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(54) PHOTOGRAPHING OPTICAL SYSTEM, IMAGE PICKUP DEVICE AND METHOD FOR CHANGING IMAGE PLANE SIZE OF PHOTOGRAPHING OPTICAL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To cope with a photoelectric conversion element having different image plane size and to realize miniaturization and high image quality by using a device in a state where a conversion optical system is arranged at the image side end of a principal optical system in the case of picking up a subject image as the image of the 2nd image plane size different from the 1st image plane size.
SOLUTION: The principal optical system L1 is a zoom lens and is constituted of a 1st

lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3 and a 4th lens group Gr4 in order from an object side, and the groups Gr1 and Gr3 are fixed type and the groups Gr2 and Gr4 are movable type in positive, negative, positive and positive four-component zoom. The group Gr1 is constituted of three lenses G1 to G3, the group Gr2 is constituted of three lenses G4 to G6, the group Gr3 is constituted of two lenses G1 and G2 and a diaphragm S, and the group Gr4 is constituted of three lenses G9 to G11. The optical system where the conversion optical system A1 is arranged between the optical system L1 and an LPF copes with the 2nd image plane size (large image plane size and height in a direction perpendicular to an optical axis Y=4.0 mm).

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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] A photographic subject image is independently consisted of the main optical system in which image formation is possible, and the conversion optical system which can be arranged in the image side edge section of this main optical system. When picturizing said photographic subject image as an image of the 1st screen size, it is used by said main optical-system independent. It is the photography optical system characterized by being used for the image side edge section of said main optical system in the condition of having arranged said conversion optical system when said 1st screen size picturizes said photographic subject image as an image of the 2nd different screen size.

[Claim 2] Said 1st screen size is photography optical system according to claim 1 characterized by being smaller than said 2nd screen size.

[Claim 3] Photography optical system according to claim 1 or 2 characterized by satisfying the following conditional expression;

$2.5<|fc/Yb|<11.0$, however the focal distance Yb of fc:conversion optical system: It is the maximum image quantity of the 2nd screen size.

[Claim 4] Photography optical system according to claim 1 to 3 characterized by satisfying the following conditional expression;

1.1<betac<1.9, however betac: It is the lateral magnification of conversion optical system.

[Claim 5] Photography optical system according to claim 1 to 4 characterized by having arranged the optical low pass filter to either of the optical paths from said main optical system to the image surface.

[Claim 6] Said photography optical system is photography optical system according to claim 1 to 5 characterized by forming an image on the light-receiving side of an optoelectric transducer.

[Claim 7] Image pick-up equipment which has said photography optical system of claim 1 corresponding to said 1st screen size, or claim 2.

[Claim 8] Image pick-up equipment which has said photography optical system of claim 1 corresponding to said 2nd screen size, or claim 2.

[Claim 9] A photographic subject image is independently constituted from main optical system in which image formation is possible, and conversion optical system which can be arranged in the image side edge section of this main optical system. When using by said main optical-system independent when picturizing said photographic subject image as an image of the 1st screen size, and picturizing said photographic subject image as an image of the 2nd different screen size from said 1st screen size The screen size conversion approach of the photography optical system characterized by using for the image side edge section of said main optical system in the condition of having arranged said conversion optical system.

[Claim 10] Said 1st screen size is the screen size conversion approach of the photography optical system according to claim 9 characterized by being smaller than said 2nd screen size.

[Claim 11] The screen size conversion approach of photography optical system according to claim 9 or 10 that photography optical system is characterized by satisfying the following conditional expression;

2.5<|fc/Yb|<11.0, however the focal distance Yb of fc:conversion optical system: It is the maximum image quantity of the 2nd screen size.

[Claim 12] The screen size conversion approach of photography optical system according to claim 9 to 11 that photography optical system is characterized by satisfying the following conditional expression;

1.1<betac<1.9, however betac: It is the lateral magnification of conversion optical system.

[Claim 13] The screen size conversion approach of the photography optical system according to claim 9 to 12 characterized by arranging the optical low pass filter at either of the optical paths from said main optical system to the image surface in said photography optical system.

[Claim 14] Said photography optical system is the screen size conversion approach of the photography optical system according to claim 9 to 13 characterized by forming an image on the light-receiving side of an optoelectric transducer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the photography optical system which can respond to the optoelectric transducer of a different screen size, concerning photography optical system and the photography optical system which can respond to a different screen size in more detail.

[0002]

[Description of the Prior Art] In recent years, the digital still camera which can capture an image easily as electronic data is spreading with the spread of personal computers. The optoelectric transducer is used for such a digital still camera. Two opposite inclinations of the inclination miniaturized in order that the screen size of such an optoelectric transducer may attain the miniaturization of a user's camera and the demand of a cost cut, and the inclination formed into the high pixel by leaving a screen size as it is in order to attain the demand of high-definition-izing of a user exist.

[0003] From the above situations, the photography optical system of dedication is used to the optoelectric transducer of a different screen size according to various requests in the field of current and a digital still camera, respectively. However, if the common photography optical system which can respond can be offered to the optoelectric transducer of a different screen size, the large cost reduction of photography optical system is expectable.

[0004] The approach of applying the photography optical system corresponding to a large screen size also to a screen size small as it is conventionally as an example of photography optical system in which it can respond to the

optoelectric transducer of a different screen size is learned. Moreover, the method of using the relay lens system which changes a scale factor and carries out re-image formation of the image formed of photography optical system to JP,8-114742,A or JP,10-319314,A as an option is proposed. Furthermore, the technique of arranging attachment and detachment or an exchangeable convertible lens group in the middle of the optical path of photography optical system, responding to a screen size, detaching, attaching or exchanging a convertible lens group for each official report of JP,10-123416,A, JP,9-329743,A, JP,9-329744,A, and JP,7-199067,A, and changing the configuration of photography optical system is proposed.

[0005]

[Problem(s) to be Solved by the Invention] However, in order that a focal distance region may shift to a long focal distance side the photography optical system corresponding to a large screen size which was mentioned above from the relation between about [that photography optical system is the big optical system beyond the need in using it with a small screen size by the approach of using also for a screen size small as it is], a field angle, and a focal distance, there is a problem of not being practical. Moreover, by the approach using the

2nd relay lens system mentioned above, since it is necessary to secure the optical path of a relay lens system, there is a problem that the whole photography optical system is enlarged very much.

[0006] Furthermore, in order to make the camera cone holding each lens group a different configuration according to a screen size or to detach, attach or exchange a convertible lens group, it is necessary to make an interstitial segment movable, and by the approach of responding to the 3rd screen size mentioned above, detaching, attaching or exchanging a convertible lens group, and changing the configuration of photography optical system, there is a problem used as a very complicated configuration. It is possible to deal with the optoelectric transducer of a different screen size in view of such a problem, and this invention aims at offering the photography optical system which can attain a miniaturization and high definition-ization.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, in this invention, independently a photographic subject image The main optical system in which image formation is possible, When it consists of the conversion optical system which can be arranged in the image side edge section of the main

optical system and picturizes said photographic subject image as an image of the 1st screen size, it is used by said main optical-system independent. When picturizing said photographic subject image as an image of the 2nd different screen size from said 1st screen size, it considers as the configuration of the photography optical system used for the image side edge section of said main optical system in the condition of having arranged said conversion optical system. Moreover, said 1st screen size is considered as a configuration smaller than said 2nd screen size.

[0008] Moreover, it considers as the configuration of the photography optical system with which are satisfied of the following conditional expression.

$2.5<|fc/Yb|<11.0$, however the focal distance Yb of fc:conversion optical system: It is the maximum image quantity of the 2nd screen size.

[0009] Furthermore, it considers as the configuration of the photography optical system with which are satisfied of the following conditional expression.

$1.1<betac<1.9$, however betac: It is the lateral magnification of conversion optical system.

[0010] Moreover, it considers as the configuration of the photography optical system which has arranged the optical low pass filter to either of the optical

paths from said main optical system to the image surface. Moreover, said photography optical system is considered as the configuration which forms an image on the light-receiving side of an optoelectric transducer.

[0011] Moreover, it considers as the configuration of the image pick-up equipment which has said photography optical system of claim 1 corresponding to said 1st screen size, or claim 2. Or it considers as the configuration of the image pick-up equipment which has said photography optical system of claim 1 corresponding to said 2nd screen size, or claim 2.

[0012] Furthermore, it considers as the screen size conversion approach of said photography optical system.

[0013]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing. drawing 1 and drawing 2 , drawing 3 and drawing 4 , drawing 5 and drawing 6 , drawing 7 , drawing 8 , drawing 9 , and drawing 10 -- respectively -- the 1- the lens configuration of the photography optical system of the 5th operation gestalt is shown.

[0014] The configuration shown in drawing 1 among the 1st operation gestalt supports the 1st screen size (a small screen size, height of Y= 3.1mm of a

direction perpendicular to an optical axis) only by the main optical system L1. The left-hand side of this drawing is a body side, and right-hand side is an image side. moreover, the main optical system L1 is a zoom lens, and consists of the 1st lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3, and a 4th lens group Gr4 sequentially from a body side -- having -- a forward negative-positive-positive 4 component zoom -- Gr1, Gr3 immobilization, and Gr2 and Gr4 -- it is a movable type. In addition, Gr1 consists of three lenses G1 and G2 and G3, Gr2 consists of three lenses G4, G5, and G6, Gr3 is extracted to two lenses G1 and G2 list, and consists of S, and Gr4 consists of three lenses G9, G10, and G11. Moreover, the parallel plate of the image side edge section is a low pass filter LPF.

[0015] The configuration shown in drawing 2 among the 1st operation gestalt supports the 2nd screen size (a large screen size, height of Y= 4.0mm of a direction perpendicular to an optical axis) by the optical system which has arranged the conversion optical system A1 among the main optical system L1 and LPF. In addition, A1 consists of two lenses G12 and G13.

[0016] The configuration shown in drawing 3 among the 2nd operation gestalt supports the 1st screen size (a small screen size, height of Y= 3.1mm of a

direction perpendicular to an optical axis) only by the main optical system L2. The left-hand side of this drawing is a body side, and right-hand side is an image side. moreover, the main optical system L2 is a zoom lens, and consists of the 1st lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3, and a 4th lens group Gr4 sequentially from a body side -- having -- the 1st operation gestalt -- the same -- a forward negative-positive-positive 4 component zoom -- Gr1, Gr3 immobilization, and Gr2 and Gr4 -- it is a movable type. In addition, Gr1 consists of three lenses G1 and G2 and G3, Gr2 consists of three lenses G4, G5, and G6, Gr3 is extracted to two lenses G1 and G2 list, and consists of S, and Gr4 consists of three lenses G9, G10, and G11. Moreover, the parallel plate of the image side edge section is a low pass filter LPF.

[0017] The configuration shown in drawing 4 among the 2nd operation gestalt supports the 2nd screen size (a large screen size, height of Y= 4.0mm of a direction perpendicular to an optical axis) by the optical system which has arranged the conversion optical system A2 among the main optical system L2 and LPF. In addition, A2 consists of two lenses G12 and G13.

[0018] The configuration shown in drawing 5 among the 3rd operation gestalt supports the 1st screen size (a small screen size, height of Y= 3.1mm of a

direction perpendicular to an optical axis) only by the main optical system L3. The left-hand side of this drawing is a body side, and right-hand side is an image side. moreover, the main optical system L3 is a zoom lens, and consists of the 1st lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3, and a 4th lens group Gr4 sequentially from a body side -- having -- the 1st operation gestalt -- the same -- a forward negative-positive-positive 4 component zoom -- Gr1, Gr3 immobilization, and Gr2 and Gr4 -- it is a movable type. In addition, Gr1 consists of three lenses G1 and G2 and G3, Gr2 consists of three lenses G4, G5, and G6, Gr3 is extracted to two lenses G1 and G2 list, and consists of S, and Gr4 consists of three lenses G9, G10, and G11. Moreover, the parallel plate of the image side edge section is a low pass filter LPF.

[0019] The configuration shown in drawing 6 among the 3rd operation gestalt supports the 2nd screen size (a large screen size, height of Y= 4.0mm of a direction perpendicular to an optical axis) by the optical system which has arranged conversion optical-system A3 among the main optical system L3 and LPF. In addition, A3 consists of two lenses G12 and G13.

[0020] The configuration shown in drawing 7 among the 4th operation gestalt supports the 1st screen size (a small screen size, height of Y= 3.1mm of a

direction perpendicular to an optical axis) only by the main optical system L4. The left-hand side of this drawing is a body side, and right-hand side is an image side. moreover, the main optical system L4 is a zoom lens, and consists of the 1st lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3, and a 4th lens group Gr4 sequentially from a body side -- having -- the 1st operation gestalt -- the same -- a forward negative-positive-positive 4 component zoom -- Gr1, Gr3 immobilization, and Gr2 and Gr4 -- it is a movable type. In addition, Gr1 consists of three lenses G1 and G2 and G3, Gr2 consists of three lenses G4, G5, and G6, Gr3 is extracted to two lenses G1 and G2 list, and consists of S, and Gr4 consists of three lenses G9, G10, and G11. Moreover, the parallel plate of the image side edge section is a low pass filter LPF.

[0021] The configuration shown in drawing 8 among the 4th operation gestalt supports the 2nd screen size (a large screen size, height of Y= 4.0mm of a direction perpendicular to an optical axis) by the optical system which has arranged conversion optical-system A4 among the main optical system L4 and LPF. In addition, A4 consists of two lenses G12 and G13.

[0022] The configuration shown in drawing 9 among the 5th operation gestalt supports the 1st screen size (a small screen size, height of Y= 2.3mm of a

direction perpendicular to an optical axis) only by the main optical system L5. The left-hand side of this drawing is a body side, and right-hand side is an image side. moreover, the main optical system L5 is a zoom lens, and consists of the 1st lens group Gr1, a 2nd lens group Gr2, a 3rd lens group Gr3, and a 4th lens group Gr4 sequentially from a body side -- having -- the 1st operation gestalt -- the same -- a forward negative-positive-positive 4 component zoom -- Gr1, Gr3 immobilization, and Gr2 and Gr4 -- it is a movable type. In addition, Gr1 consists of three lenses G1 and G2 and G3, Gr2 consists of three lenses G4, G5, and G6, Gr3 is extracted to two lenses G1 and G2 list, and consists of S, and Gr4 consists of three lenses G9, G10, and G11. Moreover, the parallel plate of the image side edge section is a low pass filter LPF.

[0023] The configuration shown in drawing 10 among the 5th operation gestalt supports the 2nd screen size (a large screen size, height of Y= 4.0mm of a direction perpendicular to an optical axis) by the optical system which has arranged conversion optical-system A5 among the main optical system L5 and LPF. In addition, A5 consists of two lenses G12 and G13.

[0024] Usually, if it is the same specification, the direction of the optical system of the 2nd screen size will become larger than the optical system of the 1st

screen size. Therefore, if conversion optical system is arranged to the optical system of the 2nd screen size and it changes into the optical system of the 1st screen size when changing a screen size, the optical system after the conversion will turn into too big optical system as optical system of the 1st screen size. Therefore, the direction which arranges conversion optical system to the optical system of the 1st screen size, and is changed into the optical system of the 2nd screen size like each above-mentioned operation gestalt can miniaturize optical system, and is very advantageous about magnitude.

[0025] Below, conditions desirable about optical system are described. As for the optical system of the 2nd screen size, it is desirable among each above-mentioned operation gestalt to satisfy the following conditional expression (1).

$2.5<|fc/Yb|<11.0$ (1)

However, the focal distance Yb of fc:conversion optical system: It is the maximum image quantity of the 2nd screen size.

[0026] Conditional expression (1) is a formula which specifies the focal distance of conversion optical system. If it becomes below the lower limit of this conditional expression, since the focal distance of conversion optical system will

become short, namely, power will become strong too much, slack type distortion aberration and amendment of a curvature of field become difficult especially also in many aberration. On the contrary, since it becomes difficult to secure magnifying power since the focal distance of conversion optical system will become long, namely, power will become weak too much, if it becomes more than a upper limit, and the focal distance in conversion optical-system arrangement order seldom changes but is on a wide angle side for the optical system of the 2nd screen size, amendment of the circumference engine performance, especially a curvature of field becomes difficult.

[0027] Moreover, as for the optical system of the 2nd screen size, it is desirable among each operation gestalt to satisfy the following conditional expression (2).

1.1<betac<1.9 (2)

However, betac: It is the lateral magnification of conversion optical system.

[0028] Conditional expression (2) is a formula which specifies the scale factor of conversion optical system. If it becomes below the lower limit of this conditional expression, a conversion scale factor becomes small too much, since the focal distance at the time of having arranged conversion optical system is not expanded, it will be on a wide angle side and amendment of a curvature of field

will become difficult. On the contrary, if it becomes more than a upper limit, a conversion scale factor will become large too much, and slack type distortion aberration and amendment of a curvature of field will become difficult especially also in many aberration.

[0029] Moreover, as for the optical system of each operation gestalt, it is desirable to satisfy the following conditional expression (3).

$0.7<(Yb/Ys)/betac<1.3$ (3)

However, Ys: It is the maximum image quantity of the 1st screen size.

[0030] Conditional expression (3) is a formula which specifies the relation between the ratio of a screen size, and a conversion scale factor, and means that a field angle becomes almost equal before and behind conversion optical system. If it deviates from the range of this conditional expression, since change of the field angle in conversion optical-system arrangement order will become large and the burden to the field angle of the main optical system which it is common and is used will become large, the increment in an overall length and a front ball diameter and the increment in the lens number of sheets accompanying aberration degradation are caused. If it becomes below the lower limit of conditional expression, in order that the focal distance after conversion

optical-system arrangement may specifically shift to a looking-far side too much, the increment in a lens system overall length and degradation of spherical aberration are caused. On the contrary, if it becomes more than a upper limit, in order that the focal distance after arrangement may shift to a wide angle side too much, degradation of the increment in a front ball diameter, a curvature of field, and distortion aberration is caused.

[0031] Moreover, as for the optical system of the 1st screen size, it is desirable among each operation gestalt to satisfy the following conditional expression (4).

$1.0<|f2|/fws<1.8$ (4)

However, f2 : The focal distance fws of the lens [2nd] group: It is the focal distance of the whole system in the wide angle edge of the optical system of the 1st screen size.

[0032] If it becomes below the lower limit of this conditional expression, since the focal distance of the 2nd lens group will become short too much, namely, the power of the 2nd lens group will become strong too much, while amendment of the negative distortion aberration in a wide angle edge becomes difficult also in any of the optical system of the 2nd screen size which has arranged the optical system and conversion optical system of the 1st screen size, **** by the side of

the undershirt of a curvature of field becomes remarkable. On the contrary, if it becomes more than a upper limit, the movement magnitude in the case of the variable power of the 2nd lens group will increase, and increase of a front ball diameter will be caused in connection with it.

[0033] In addition, although each operation gestalt showed the example which adds conversion optical system, without completely changing the configuration of the main optical system, and changes a screen size, this invention is not limited to this. For example, after changing a part of configuration, without making the main properties of the main optical system change, conversion optical system may be added. The addition of the so-called bending, the aspheric surface, or a diffraction optical surface which changes radius of curvature, without changing the power of the single lens component which constitutes the main optical system as an example which does not make the main properties of the main optical system change is mentioned. Moreover, it is also the criteria of the example which does not make the main properties of the main optical system change to add the spherical lens of power respectively weak [sake / for image surface engine-performance amendment], a cemented lens, an aspheric lens, a diffracted-light study lens, etc. to the main optical system.

[0034] When it corresponds to a large screen size especially, in order for the number of pixels of an optoelectric transducer to become large and to raise optical-character ability rather than the case of a small screen size, the above modification of a part of main optical system is effective from a viewpoint of the improvement in optical-character ability. Moreover, although each operation gestalt showed the example by which the main optical system and conversion optical system are altogether constituted from a refracting interface, according to the situation of image pick-up equipment, the configuration which arranges a mirror and bends an optical path in an optical path, the configuration using a diffracted-light study component, etc. may be adopted.

[0035] Furthermore, although each operation gestalt showed the example of the photography optical system which can respond to the optoelectric transducer of different size, the technique of each operation gestalt is applicable also to the photography optical system corresponding to the optoelectric transducer of a small screen size, and the silver halide film of a large screen size, the photography optical system corresponding to the conventional 35mm silver halide film and the silver halide film (the so-called Advanced Photo system, APS format) of a new rank, etc., for example.

[0036] Hereafter, construction data, an aberration Fig., etc. are mentioned and the configuration of the photography optical system concerning this invention is shown still more concretely. In addition, the optical system of the 1st screen size of the next examples 1-5, and the 2nd screen size The optical system of the 1st screen size of the 5th operation gestalt and the 2nd screen size is supported, respectively. the 1- mentioned above -- the 1- the lens block diagram (drawing 1 - drawing 10) showing the photography optical system (the 1st screen size and the 2nd screen size) of the 5th operation gestalt shows the lens configuration of the optical system of the 1st screen size of the corresponding examples 1-5, and the 2nd screen size, respectively.

[0037] In each example ri (i= 1, 2, 3 ...) It counts from a body side and is i. The field of eye watch and its radius of curvature are shown. di (i= 1, 2, 3 ...) It counts from a body side and is i. Axial top-face spacing of eye watch is shown, and they are nickel (i= 1, 2, 3 ...) and nui (i= 1, 2, 3 ...). It counts from a body side, respectively and is i. The refractive index and the Abbe number to d line of the lens of eye watch are shown. Moreover, the focal distance f of the whole system in an example and the f number FNO of the whole system, In a list, spacing with spacing of the 1st lens group and the 2nd lens group, spacing of the 2nd lens

group and the 3rd lens group, spacing of the 3rd lens group and the 4th lens group and the main optical-system last lens group and LPF, or conversion optical system Sequentially from the left, a wide angle edge (W), a middle focal distance (M), and each value in a tele edge (T) are supported. In addition, the formula which shows that the field which gave * mark to radius of curvature is a field which consisted of the aspheric surfaces among each example, and expresses the field configuration of the aspheric surface is defined below.

[0038]

X=X0+sigmaAiYi ..... (a)

X0 =CY2/{1+(1-epsilonC 2Y2) 1 / 2} ..... (b)

However, X : The amount Y of displacement from the datum level of the direction of an optical axis : Height C of a direction perpendicular to an optical axis : Paraxial curvature epsilon : Secondary curved-surface parameter Ai : It is the i-th aspheric surface multiplier.

[0039]

<<example 1(1st screen size)>>

f= 5.1mm - 12.0mm - 29.4mm (whole system focal distance)

FNO=2.28 - 2.51 - 2.88 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 39.361 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 25.444 d2= 3.932 N 2= 1.48749 nu2= 70.44 r3=-92.731 d3= 0.100 r4= 18.735 d4= 1.976 N 3= 1.65364 nu3= 55.78 r5= 35.205 d5= 0.500 - 8.755 -14.831r6*= 49.390 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.170 d7= 4.459r8= -9.753 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 12.601 d9= 1.268 N 6= 1.83350 nu6= 21.00r10= 57.770 d10=14.831 - 6.576 - 0.500 r11= infinity (diaphragm) d11= 0.500r12= 15.739 d12= 1.546 N 7= 1.75450 nu7= 51.57 r13=-113.832 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=41.438 d14= 4.732 - 2.453 - 0.200 r15= 6.813 d15= 3.315 N 9= 1.63237 nu9= 48.67r16=-34.984 d16= 1.181 r17*=-49.645 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*= 9.148 d18= 1.869 r19= 11.635 d19= 2.378 N 11= 1.54012 nu11=63.99r20=-15.552 d20= 1.359 - 3.641 - 5.877 r21= infinity d21= 3.400 N 12= 1.51680 nu12= 64.20r22= infinity [0040]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.26307x10-4 A6= 0.24482x10-5 A8= -0.30163x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.92198x10-5 A6= 0.24720x10-5 A8= 0.22450x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.30309x10-4 A6= 0.27800x10-5 A8=-0.29431x10-6 A10=

0.11555x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.47983x10-3 A6= 0.34008x10-5 A8=-0.15789x10-6 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.49212x10-3 A6= 0.16988x10-4 A8= 0.50803x10-6 [0041]

<<example 1(2nd screen size)>>

f= 6.6mm - 15.5mm - 38.1mm (whole system focal distance)

FNO=2.93 - 3.24 - 3.72 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 39.361 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 25.444 d2= 3.932 N 2= 1.48749 nu2= 70.44 r3=-92.731 d3= 0.100 r4= 18.735 d4= 1.976 N 3= 1.65364 nu3= 55.78 r5= 35.205 d5= 0.500 - 8.755 -14.831r6*= 49.390 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.170 d7= 4.459r8= -9.753 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 12.601 d9= 1.268 N 6= 1.83350 nu6= 21.00r10= 57.770 d10=14.831 - 6.576 - 0.500 r11= infinity (diaphragm) d11= 0.500r12= 15.739 d12= 1.546 N 7= 1.75450 nu7= 51.57 r13=-113.832 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=41.438 d14= 4.732 - 2.453 - 0.200 r15= 6.813 d15= 3.315 N 9= 1.63237 nu9= 48.67r16=-34.984 d16= 1.181 r17*=-49.645 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*=9.148 d18= 1.869 r19= 11.635 d19= 2.378 N 11=

1.54012 nu11= 63.99r20=-15.552 d20= 0.400 - 2.679 - 4.932 r21= 71.678 d21= 0.800 N 12= 1.75450 nu12= 51.57r22= 6.056 d22= 0.121r23= 6.248 d23= 2.244 N 13= 1.57058 nu13= 39.32r24= 33.647 d24= 1.000 r25= infinity d25= 3.400 N 14= 1.51680 nu14= 64.20r26= infinity [0042]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.26307x10-4 A6= 0.24482x10-5 A8= -0.30163x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.92198x10-5 A6= 0.24720x10-5 A8= 0.22450x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.30309x10-4 A6= 0.27800x10-5 A8=-0.29431x10-6 A10= 0.11555x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.47983x10-3 A6= 0.34008x10-5 A8=-0.15789x10-6 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.49212x10-3 A6= 0.16988x10-4 A8= 0.50803x10-6 [0043]

<<example 2(1st screen size)>>

f= 5.1mm - 12.0mm - 29.4mm (whole system focal distance)

FNO=2.28 - 2.51 - 2.88 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 44.384 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 26.902 d2=

3.548 N 2= 1.48749 nu2= 70.44 r3=-87.224 d3= 0.100 r4= 18.690 d4= 1.903 N 3= 1.71785 r5= 34.111 d5= 0.500 - 8.898 -15.092r6*=53.697 d6= 0.750 N 4= 1.77250 nu3= 49.77 r7*= 7.151 d7= 4.412r8= -9.136 d8= 0.700 N 5= 1.48749 r9= 14.748 d9= 1.249 N 6= 1.83350 nu4= 21.00r10=166.857 d10=15.092 - 6.694 - 0.500 r11= infinity (diaphragm) d11= 0.500r12= 16.402 d12= 1.569 N 7= 1.75450 r13=-73.572 d13= 1.000 N 8= 1.84666 nu5= 23.82r14*=47.167 d14= 4.771 - 2.465 - 0.200 r15= 6.930 d15= 3.195 N9=1.64598r16=-49.092 d16= 1.247 r17*=-259.880 d17= 1.000 N 10= 1.84666 nu6= 23.82r18*= 8.606 d18= 2.029 r19= 10.973 d19= 2.385 N11=1.48757r20=-15.859 d20= 1.336 - 3.642 - 5.907 r21= infinity d21= 3.400 N 12= 1.51680 nu7= 64.20r22= infinity [0044] [page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.50768x10-4 A6= 0.27040x10-5 A8= -0.32896x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.26886x10-5 A6= 0.24656x10-5 A8= 0.28044x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.29944x10-4 A6= 0.23942x10-5 A8=-0.26510x10-6 A10= 0.10143x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.43785x10-3 A6=-0.85525x10-6 A8=-0.55200x10-7 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.49210x10-3

A6= 0.12730x10-4 A8= 0.66578x10-6 [0045]

<<example 2(2nd screen size)>>

f= 6.6mm - 15.5mm - 38.1mm (whole system focal distance)

FNO=2.9 - 3.22 - 3.72 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 44.384 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 26.902 d2= 3.548 N2=1.48749 r3=-87.224 d3= 0.100 r4= 18.690 d4= 1.903 N 3= 1.71785 r5= 34.111 d5= 0.500 - 8.898 -15.092r6*= 53.697 d6= 0.750 N 4= 1.77250 nu2= 49.77 r7*= 7.151 d7= 4.412r8=-9.136 d8= 0.700 N 5= 1.48749 r9= 14.748 d9= 1.249 N 6= 1.83350 nu3= 21.00r10=166.857 d10=15.092 - 6.694 - 0.500 r11= infinity (diaphragm) d11= 0.500r12= 16.402 d12= 1.569 N7=1.75450r13=-73.572 d13= 1.000 N 8= 1.84666 nu4= 23.82r14*=47.167 d14= 4.771 - 2.465 - 0.200 r15= 6.930 d15= 3.195 N9=1.64598r16=-49.092 d16= 1.247 r17*=-259.880 d17=1.000 N 10= 1.84666 nu5= 23.82r18*= 8.606 d18= 2.029 r19= 10.973 d19= 2.385 N11=1.48757r20=-15.859 d20= 0.100 - 2.405 - 4.671 r21= 49.436 d21= 0.600 N12=1.75450r22= 5.976 d22= 0.102 r23= 6.145 d23= 1.807 N13=1.57277r24= 28.181 d24= 1.000r25= infinity d25= 3.400 N 14= 1.51680 nu6= 64.20r26= infinity [0046]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.50768x10-4 A6= 0.27040x10-5 A8= -0.32896x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.26886x10-5 A6= 0.24656x10-5 A8= 0.28044x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.29944x10-4 A6= 0.23942x10-5 A8=-0.26510x10-6 A10= 0.10143x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.43785x10-3 A6=-0.85525x10-6 A8=-0.55200x10-7 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.49210x10-3 A6= 0.12730x10-4 A8= 0.66578x10-6 [0047]

<<example 3(1st screen size)>>

f= 5.1mm - 12.0mm - 29.4mm (whole system focal distance)

FNO=2.28 - 2.51 - 2.88 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 38.100 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 25.197 d2= 4.072 N 2= 1.48749 nu2= 70.44 r3=-98.604 d3= 0.100 r4= 19.021 d4= 2.041 N 3= 1.63412 nu3= 56.85 r5= 36.020 d5= 0.500 - 8.861 -14.981r6*= 49.673 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.233 d7= 4.595r8= -9.793 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 12.800 d9= 1.273 N 6= 1.83350 nu6= 21.00r10= 60.435

d10=14.981 - 6.620 - 0.500r11= infinity (diaphragm) d11= 0.500r12= 15.868 d12= 1.517 N 7= 1.75450 nu7= 51.57 r13=-296.209 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=35.961 d14= 4.773 - 2.488 - 0.200 r15= 6.619 d15= 3.473 N 9= 1.56380 nu9= 47.92r16=-24.792 d16= 1.309 r17*=-23.223 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*=11.411 d18= 1.585 r19= 12.595 d19= 2.498 N 11= 1.58242 nu11= 60.28r20=-13.465 d20= 1.343 - 3.628 - 5.916 r21= infinity d21= 3.400 N 12= 1.51680 nu12= 64.20r22= infinity [0048]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.29472x10-4 A6= 0.19378x10-5 A8= -0.23877x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.60653x10-5 A6= 0.20752x10-5 A8= 0.17680x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.32613x10-4 A6= 0.21765x10-5 A8=-0.22337x10-6 A10= 0.89525x10-8 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.50533x10-3 A6= 0.65302x10-5 A8=-0.26699x10-6 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.46260x10-3 A6= 0.18637x10-4 A8= 0.25741x10-6 [0049]

<<example 3(2nd screen size)>>

f= 7.3mm - 17.2mm - 42.0mm (whole system focal distance)

FNO=3.26 - 3.58 - 4.12 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 38.100 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 25.197 d2= 4.072 N 2= 1.48749 nu2= 70.44 r3=-98.604 d3= 0.100 r4= 19.021 d4= 2.041 N 3= 1.63412 nu3= 56.85 r5= 36.020 d5= 0.500 - 8.861 -14.981r6*= 49.673 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.233 d7= 4.595r8= -9.793 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 12.800 d9= 1.273 N 6= 1.83350 nu6= 21.00r10= 60.435 d10=14.981 - 6.620 - 0.500r11= infinity (diaphragm) d11= 0.500r12= 15.868 d12= 1.517 N 7= 1.75450 nu7= 51.57 r13=-296.209 d13= 0.010r14=-296.203 d14= 1.000 N 8= 1.84666 nu8= 23.82r15*=35.961 d15= 4.773 - 2.488 - 0.200 r16= 6.619 d16= 3.473 N 9= 1.56380 nu9= 47.92r17=-24.792 d17= 1.309 r18*=-23.223 d18= 1.000 N 10= 1.84666 nu10= 23.82r19*=11.411 d19= 1.585 r20= 12.595 d20= 2.498 N 11= 1.58242 nu11= 60.28r21=-13.465 d21= 0.400 -2.685 - 4.973 r22= 41.840 d22= 0.800 N 12= 1.75450 nu12= 51.57r23= 5.885 d23= 0.245 r24= 6.199 d24= 2.016 N 13= 1.59891 nu13= 35.03r25= 16.340 d25= 1.000 r26= infinity d26= 3.400 N 14= 1.51680 nu14= 64.20r27= infinity

[0050]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4=

0.29472x10-4 A6= 0.19378x10-5 A8= -0.23877x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.60653x10-5 A6= 0.20752x10-5 A8= 0.17680x10-6 [Page [15th] (r15) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.32613x10-4 A6= 0.21765x10-5 A8=-0.22337x10-6 A10= 0.89525x10-8 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.50533x10-3 A6= 0.65302x10-5 A8=-0.26699x10-6 [Page [19th] (r19) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.46260x10-3 A6= 0.18637x10-4 A8= 0.25741x10-6 [0051]

<<example 4(1st screen size)>>

f= 5.1mm - 12.0mm - 29.4mm (whole system focal distance)

FNO=2.3 - 2.53 - 2.88 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 51.292 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 28.707 d2= 3.874 N 2= 1.49411 nu2= 69.48 r3=-88.318 d3= 0.100 r4= 19.533 d4= 2.187 N 3= 1.74575 nu3= 51.87 r5= 38.766 d5= 0.500 - 8.903 -15.126r6*= 76.536 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.248 d7= 4.289r8= -9.577 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 14.103 d9= 1.327 N 6= 1.83350 nu6= 21.00r10=119.341 d10=15.126 - 6.723 - 0.500r11= infinity (diaphragm) d11=

0.500r12= 14.886 d12= 1.645 N 7= 1.76163 nu7= 50.36 r13=-54.790 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=47.323 d14= 4.717 - 2.400 - 0.200 r15= 7.049 d15= 3.069 N 9= 1.65030 nu9= 49.41r16=-87.401 d16= 1.297 r17*=107.653 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*= 7.817 d18= 1.736 r19= 10.410 d19= 2.338 N 11= 1.48749 nu11= 70.44r20=-16.932 d20= 1.351 - 3.667 - 5.867 r21= infinity d21= 3.400 N 12= 1.51680 nu12= 64.20r22= infinity

[0052]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.15037x10-3 A6=-0.41303x10-6 A8= -0.67332x10-8 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.11096x10-3 A6= 0.25794x10-5 A8= 0.16455x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.30579x10-4 A6= 0.34943x10-5 A8=-0.41149x10-6 A10= 0.16505x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.46605x10-3 A6= 0.42583x10-6 A8=-0.17528x10-8 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.39333x10-3 A6= 0.12845x10-4 A8= 0.65431x10-6 [0053]

<<example 4(2nd screen size)>>

f= 6.0mm - 14.1mm - 34.6mm (whole system focal distance)

FNO=2.73 - 3.0 - 3.4 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 51.292 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 28.707 d2= 3.874 N 2= 1.49411 nu2= 69.48 r3=-88.318 d3= 0.100 r4= 19.533 d4= 2.187 N 3= 1.74575 nu3= 51.87 r5= 38.766 d5= 0.500 - 8.903 -15.126r6*= 76.536 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 7.248 d7= 4.289r8= -9.577 d8= 0.700 N 5= 1.48749 nu5= 70.44 r9= 14.103 d9= 1.327 N 6= 1.83350 nu6= 21.00r10=119.341 d10=15.126 - 6.723 - 0.500r11= infinity (diaphragm) d11= 0.500r12= 14.886 d12= 1.645 N 7= 1.76163 nu7= 50.36 r13=-54.790 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=47.323 d14= 4.717 - 2.400 - 0.200 r15= 7.049 d15= 3.069 N 9= 1.65030 nu9= 49.41r16=-87.401 d16= 1.297 r17*=107.653 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*= 7.817 d18= 1.736 r19= 10.410 d19= 2.338 N 11= 1.48749 nu11= 70.44r20=-16.932 d20= 0.400 - 2.717 - 4.917 r21=117.244 d21= 0.800 N 12= 1.75450 nu12= 51.57r22= 6.400 d22= 0.100 r23= 6.592 d23= 2.286 N13=1.64387nu13= 44.47r24=45.168 d24= 1.000r25= infinity d25= 3.400 N 14= 1.51680 nu14= 64.20r26= infinity [0054]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.15037x10-3 A6=-0.41303x10-6 A8= -0.67332x10-8 [a page [7th] (r7)

aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.11096x10-3 A6= 0.25794x10-5 A8= 0.16455x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.30579x10-4 A6= 0.34943x10-5 A8=-0.41149x10-6 A10= 0.16505x10-7 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.46605x10-3 A6= 0.42583x10-6 A8=-0.17528x10-8 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.39333x10-3 A6= 0.12845x10-4 A8= 0.65431x10-6 [0055]

<<example 5(1st screen size)>>

f= 3.8mm - 9.0mm - 21.7mm (whole system focal distance)

FNO=2.34 - 2.52 - 2.88 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe number (nud)] r1= 33.893 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 20.854 d2= 2.933 N 2= 1.48749 nu2= 70.44 r3=3458.532 d3= 0.100 r4= 18.532 d4= 2.028 N 3= 1.75409 nu3= 51.58 r5= 52.594 d5= 0.500 - 7.990 -13.134r6*= 54.228 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 5.734 d7= 3.716r8= -9.442 d8= 0.700 N 5= 1.51435 nu5= 54.87 r9= 10.231 d9= 1.262 N 6= 1.83350 nu6= 21.00r10= 82.356 d10=13.134 - 5.644 - 0.500r11= infinity (diaphragm) d11= 0.500r12= 12.294 d12= 1.696 N 7= 1.70084 nu7= 26.54 r13=-12.693 d13= 1.000 N 8= 1.84666

nu8= 23.82r14*=22.033 d14= 3.925 - 2.101 - 0.200 r15= 6.741 d15= 5.913 N 9= 1.50423 nu9= 59.67r16=-9.980 d16= 1.116 r17*=-6.796 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*=-127.113 d18= 0.100 r19= 12.962d 19= 3.236 N 11= 1.61322 nu11= 48.97r20=-7.908 d20= 1.731 - 3.554 - 5.455 r21= infinity d21= 3.400 N 12= 1.51680 nu12= 64.20r22= infinity [0056]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.17992x10-3 A6= 0.21097x10-5 A8= -0.60366x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.10422x10-3 A6= 0.71873x10-5 A8= 0.67492x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.20982x10-4 A6= 0.10888x10-4 A8=-0.19610x10-5 A10= 0.12639x10-6 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.82030x10-3 A6= 0.27014x10-4 A8=-0.40805x10-6 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.26263x10-3 A6= 0.42079x10-4 A8=-0.49132x10-6 [0057]

<<example 5(2nd screen size)>>

f= 6.6mm - 15.7mm - 37.8mm (whole system focal distance)

FNO=4.11 - 4.43 - 5.0 (f number)

[Radius of curvature] [Axial top-face spacing] [Refractive index (Nd)] [The Abbe

number (nud)] r1= 33.893 d1= 0.800 N 1= 1.83350 nu1= 21.00r2= 20.854 d2= 2.933 N 2= 1.48749 nu2= 70.44 r3=3458.532 d3= 0.100 r4= 18.532 d4= 2.028 N 3= 1.75409 nu3= 51.58 r5= 52.594 d5= 0.500 - 7.990 -13.134r6*= 54.228 d6= 0.750 N 4= 1.77250 nu4= 49.77 r7*= 5.734 d7= 3.716r8= -9.442 d8= 0.700 N 5= 1.51435 nu5= 54.87 r9= 10.231 d9= 1.262 N 6= 1.83350 nu6= 21.00r10= 82.356 d10=13.134 - 5.644 - 0.500r11= infinity (diaphragm) d11= 0.500r12= 12.294 d12= 1.696 N 7= 1.70084 nu7= 26.54 r13=-12.693 d13= 1.000 N 8= 1.84666 nu8= 23.82r14*=22.033 d14= 3.925 - 2.101 - 0.200 r15= 6.741 d15= 5.913 N 9= 1.50423 nu9= 59.67r16=-9.980 d16= 1.116 r17*=-6.796 d17= 1.000 N 10= 1.84666 nu10= 23.82r18*=-127.113 d18= 0.100 r19= 12.962d 19= 3.236 N 11= 1.61322 nu11= 48.97r20=-7.908 d20= 0.400 - 2.224 - 4.125 r21= 33.371 d21= 0.800 N 12= 1.75450 nu12= 51.57r22= 5.500 d22= 0.660 r23= 6.120 d23= 1.747 N 13= 1.71069 nu13= 26.02r24= 8.790 d24= 1.000 r25= infinity d25= 3.400 N 14= 1.51680 nu14= 64.20r26= infinity [0058]

[page [6th] (r6) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.17992x10-3 A6= 0.21097x10-5 A8= -0.60366x10-7 [a page [7th] (r7) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.10422x10-3 A6= 0.71873x10-5 A8= 0.67492x10-6 [Page [14th] (r14) aspheric surface multiplier] epsilon=

0.10000x10 A4= 0.20982x10-4 A6= 0.10888x10-4 A8=-0.19610x10-5 A10= 0.12639x10-6 [Page [17th] (r17) aspheric surface multiplier] epsilon= 0.10000x10 A4=-0.82030x10-3 A6= 0.27014x10-4 A8=-0.40805x10-6 [Page [18th] (r18) aspheric surface multiplier] epsilon= 0.10000x10 A4= 0.26263x10-3 A6= 0.42079x10-4 A8=-0.49132x10-6 [0059] Moreover, drawing 11 - drawing 20 are the aberration Figs. of the infinite distance corresponding to the optical system of the 1st screen size of said examples 1-5, and the 2nd screen size, respectively, in each drawing, as for the upper case, a wide angle edge [W] and the middle express a middle focal distance [M], and the lower berth expresses the tele edge [T], respectively. And in the spherical-aberration Fig., d line is expressed and, as for the continuous line (d), the broken line (SC) expresses sine condition. Moreover, in the astigmatism Fig., the continuous line (DS) and the broken line (DM) express the astigmatism in a sagittal side and a meridional side, respectively. The above-mentioned conditional expression (1) - (4) is satisfied in the optical system of the screen size which corresponds among examples 1-5, respectively (refer to explanation of above-mentioned conditional expression). Moreover, below, the value of said conditional-expression (1) - (4) in the optical system of the corresponding screen size of each examples 1-5 is

shown.

[0060]

| fc/Yb| betac (Yb/Ys) /betac |f2|/fws example 1 6.42 1.29 1.00 1.37 examples 2 6.69 1.29 1.00 1.39 examples 3 5.15 1.43 0.90 1.38 examples 4 9.17 1.18 1.09 1.38 examples 5 3.34 1.74 1.00 1.59 [0061]

[Effect of the Invention] According to this invention, as explained above, it is possible to deal with the optoelectric transducer of a different screen size, and in order to attain a miniaturization and high definition-ization, suitable photography optical system can be offered.

[0062] If especially based on claim 1, a camera cone configuration can be simplified and a miniaturization can be attained.

[0063] Moreover, if based on claim 2, optical system can be miniaturized further.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Drawing showing the lens configuration of the photography optical system (the 1st screen size) of the 1st operation gestalt.

[Drawing 2] Drawing showing the lens configuration of the photography optical system (the 2nd screen size) of the 1st operation gestalt.

[Drawing 3] Drawing showing the lens configuration of the photography optical system (the 1st screen size) of the 2nd operation gestalt.

[Drawing 4] Drawing showing the lens configuration of the photography optical system (the 2nd screen size) of the 2nd operation gestalt.

[Drawing 5] Drawing showing the lens configuration of the photography optical system (the 1st screen size) of the 3rd operation gestalt.

[Drawing 6] Drawing showing the lens configuration of the photography optical system (the 2nd screen size) of the 3rd operation gestalt.

[Drawing 7] Drawing showing the lens configuration of the photography optical system (the 1st screen size) of the 4th operation gestalt.

[Drawing 8] Drawing showing the lens configuration of the photography optical system (the 2nd screen size) of the 4th operation gestalt.

[Drawing 9] Drawing showing the lens configuration of the photography optical system (the 1st screen size) of the 5th operation gestalt.

[Drawing 10] Drawing showing the lens configuration of the photography optical system (the 2nd screen size) of the 5th operation gestalt.

[Drawing 11] The aberration Fig. of the infinite distance corresponding to an example 1 (the 1st screen size).

[Drawing 12] The aberration Fig. of the infinite distance corresponding to an example 1 (the 2nd screen size).

[Drawing 13] The aberration Fig. of the infinite distance corresponding to an example 2 (the 1st screen size).

[Drawing 14] The aberration Fig. of the infinite distance corresponding to an example 2 (the 2nd screen size).

[Drawing 15] The aberration Fig. of the infinite distance corresponding to an example 3 (the 1st screen size).

[Drawing 16] The aberration Fig. of the infinite distance corresponding to an example 3 (the 2nd screen size).

[Drawing 17] The aberration Fig. of the infinite distance corresponding to an example 4 (the 1st screen size).

[Drawing 18] The aberration Fig. of the infinite distance corresponding to an example 4 (the 2nd screen size).

[Drawing 19] The aberration Fig. of the infinite distance corresponding to an example 5 (the 1st screen size).

[Drawing 20] The aberration Fig. of the infinite distance corresponding to an example 5 (the 2nd screen size).

[Description of Notations]

L1-L5 Main optical system

LPF Low pass filter

A1 - A5 Conversion optical system

Gr1 The 1st lens group

Gr2 The 2nd lens group

Gr3 The 3rd lens group

Gr4 The 4th lens group

G1-G13 Lens

S Drawing

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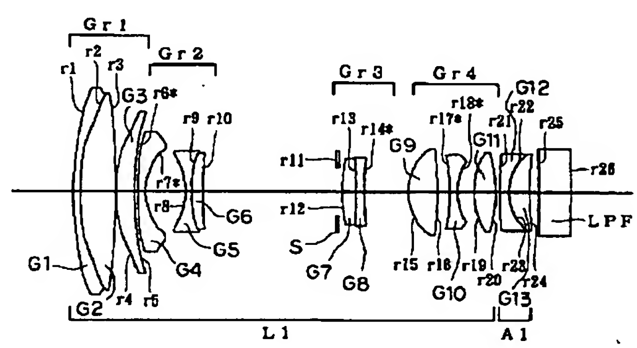
(54)【発明の名称】　撮影光学系及び撮像装置並びに撮影光学系の画面サイズ変換方法

(57)【要約】
【課題】異なる画面サイズの光電変換素子に対応する事が可能であり、小型化，高画質化を達成するために好適な撮影光学系を提供する。
【解決手段】被写体像を結像する主光学系Ｌ１の像側端部に変換光学系Ａ１を配置する事により、画面サイズを変換する構成とする。



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【特許請求の範囲】

【請求項１】　単独で被写体像を結像可能な主光学系と、該主光学系の像側端部に配置可能な変換光学系とから成り、前記被写体像を第１画面サイズの画像として撮像する場合は前記主光学系単独で用いられ、前記被写体像を前記第１画面サイズとは異なる第２画面サイズの画像として撮像する場合は、前記主光学系の像側端部に前記変換光学系を配置した状態で用いられる事を特徴とする撮影光学系。

【請求項２】　前記第１画面サイズは前記第２画面サイズよりも小さい事を特徴とする請求項１に記載の撮影光学系。

【請求項３】　以下の条件式を満足する事を特徴とする請求項１又は請求項２に記載の撮影光学系；

２．５＜｜ｆｃ／Ｙｂ｜＜１１．０

但し、

ｆｃ：変換光学系の焦点距離

Ｙｂ：第２画面サイズの最大像高

である。

【請求項４】　以下の条件式を満足する事を特徴とする請求項１乃至請求項３のいずれかに記載の撮影光学系；

１．１＜βｃ＜１．９

但し、

βｃ：変換光学系の横倍率

である。

【請求項５】　前記主光学系から像面までの光路のいずれかに、光学的ローパスフィルターを配置した事を特徴とする請求項１乃至請求項４のいずれかに記載の撮影光学系。

【請求項６】　前記撮影光学系は、光電変換素子の受光面上に画像を形成する事を特徴とする請求項１乃至請求項５のいずれかに記載の撮影光学系。

【請求項７】　前記第１画面サイズに対応した請求項１又は請求項２の前記撮影光学系を有する撮像装置。

【請求項８】　前記第２画面サイズに対応した請求項１又は請求項２の前記撮影光学系を有する撮像装置。

【請求項９】　単独で被写体像を結像可能な主光学系と、該主光学系の像側端部に配置可能な変換光学系とから構成され、前記被写体像を第１画面サイズの画像として撮像する場合は前記主光学系単独で用い、前記被写体像を前記第１画面サイズとは異なる第２画面サイズの画像として撮像する場合は、前記主光学系の像側端部に前記変換光学系を配置した状態で用いる事を特徴とする撮影光学系の画面サイズ変換方法。

【請求項１０】　前記第１画面サイズは前記第２画面サイズよりも小さい事を特徴とする請求項９に記載の撮影光学系の画面サイズ変換方法。

【請求項１１】　撮影光学系が以下の条件式を満足する事を特徴とする請求項９又は請求項１０に記載の撮影光学系の画面サイズ変換方法；

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２．５＜｜ｆｃ／Ｙｂ｜＜１１．０

但し、

ｆｃ：変換光学系の焦点距離

Ｙｂ：第２画面サイズの最大像高

である。

【請求項１２】　撮影光学系が以下の条件式を満足する事を特徴とする請求項９乃至請求項１１のいずれかに記載の撮影光学系の画面サイズ変換方法；

１．１＜βｃ＜１．９

但し、

βｃ：変換光学系の横倍率

である。

【請求項１３】　前記撮影光学系において、前記主光学系から像面までの光路のいずれかに、光学的ローパスフィルターが配置されている事を特徴とする請求項９乃至請求項１２のいずれかに記載の撮影光学系の画面サイズ変換方法。

【請求項１４】　前記撮影光学系は、光電変換素子の受光面上に画像を形成する事を特徴とする請求項９乃至請求項１３のいずれかに記載の撮影光学系の画面サイズ変換方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、撮影光学系、更に詳しくは、異なる画面サイズに対応可能な撮影光学系に関し、例えば、異なる画面サイズの光電変換素子に対応可能な撮影光学系に関する。

【０００２】

【従来の技術】近年、パーソナルコンピュータの普及に伴い、電子データとして手軽に画像を取り込めるデジタルスチルカメラが普及しつつある。このようなデジタルスチルカメラには光電変換素子が用いられている。このような光電変換素子の画面サイズは、ユーザーのカメラの小型化及びコストダウンの要求を達成するため小型化されていく傾向と、ユーザーの高画質化の要求を達成するため画面サイズをそのままにして高画素化されていく傾向という２つの相反する傾向が存在する。

【０００３】以上のような事情から、現在、デジタルスチルカメラの分野においては、様々な要望に応じた異なる画面サイズの光電変換素子に対して、それぞれ専用の撮影光学系が用いられている。しかしながら、異なる画面サイズの光電変換素子に対して、対応可能な共通の撮影光学系が提供できれば、撮影光学系の大幅なコスト削減が期待できる。

【０００４】異なる画面サイズの光電変換素子に対応可能な撮影光学系の具体例としては、従来、大きい画面サイズに対応した撮影光学系を、そのまま小さい画面サイズにも適用する方法が知られている。また、別の方法として、特開平８－１１４７４２号公報或いは特開平１０－３１９３１４号公報には、撮影光学系によって形成さ

れた画像を、倍率を変化させて再結像させるリレーレンズ系を用いるという方法が提案されている。さらに、特開平１０－１２３４１６号、特開平９－３２９７４３号、特開平９－３２９７４４号、特開平７－１９９０６７号の各公報には、撮影光学系の光路途中に着脱或いは交換可能な変換レンズ群を配置し、画面サイズに応じて変換レンズ群を着脱或いは交換して撮影光学系の構成を変更する技術が提案されている。

【０００５】

【発明が解決しようとする課題】しかしながら、上述したような、大きい画面サイズに対応した撮影光学系を、そのまま小さい画面サイズにも用いるという方法では、小さい画面サイズで使用する場合には、撮影光学系が必要以上に大きな光学系となっているばかりか、画角と焦点距離の関係から焦点距離域が長焦点距離側へシフトしてしまうため実用的でないという問題がある。また、上述した第２の、リレーレンズ系を用いる方法では、リレーレンズ系の光路を確保する必要があるため、撮影光学系全体が非常に大型化するという問題がある。

【０００６】さらに、上述した第３の、画面サイズに応じて変換レンズ群を着脱或いは交換して撮影光学系の構成を変更する方法では、各レンズ群を保持する鏡胴を画面サイズに応じて異なる構成にしておくか、変換レンズ群を着脱或いは交換するために中間部分を可動にしておく必要があり、非常に複雑な構成となる問題がある。本発明は、このような問題に鑑み、異なる画面サイズの光電変換素子に対応する事が可能であり、小型化，高画質化を達成する事ができる撮影光学系を提供する事を目的とする。

【０００７】

【課題を解決するための手段】上記目的を達成するために、本発明では、単独で被写体像を結像可能な主光学系と、その主光学系の像側端部に配置可能な変換光学系とから成り、前記被写体像を第１画面サイズの画像として撮像する場合は前記主光学系単独で用いられ、前記被写体像を前記第１画面サイズとは異なる第２画面サイズの画像として撮像する場合は、前記主光学系の像側端部に前記変換光学系を配置した状態で用いられる撮影光学系の構成とする。また、前記第１画面サイズは前記第２画面サイズよりも小さい構成とする。

【０００８】また、以下の条件式を満足する撮影光学系の構成とする。

$$2.5 < |fc / Yb| < 11.0$$

但し、

ｆｃ：変換光学系の焦点距離

Ｙｂ：第２画面サイズの最大像高

である。

【０００９】さらに、以下の条件式を満足する撮影光学系の構成とする。

$$1.1 < \beta c < 1.9$$

但し、

βｃ：変換光学系の横倍率

である。

【００１０】また、前記主光学系から像面までの光路のいずれかに、光学的ローパスフィルターを配置した撮影光学系の構成とする。また、前記撮影光学系は、光電変換素子の受光面上に画像を形成する構成とする。

【００１１】また、前記第１画面サイズに対応した請求項１又は請求項２の前記撮影光学系を有する撮像装置の構成とする。或いは、前記第２画面サイズに対応した請求項１又は請求項２の前記撮影光学系を有する撮像装置の構成とする。

【００１２】さらに、前記撮影光学系の画面サイズ変換方法とする。

【００１３】

【発明の実施の形態】以下、本発明の実施の形態について、図面を参照しながら説明する。図１及び図２，図３及び図４，図５及び図６，図７及び図８，そして図９及び図１０は、それぞれ第１～第５の実施形態の撮影光学系のレンズ構成を示している。

【００１４】第１の実施形態の内、図１に示す構成は、主光学系Ｌ１のみで第１画面サイズ（小さい画面サイズ，光軸と垂直な方向の高さＹ＝３．１ｍｍ）に対応している。同図の左側が物体側、右側が像側である。また、主光学系Ｌ１はズームレンズであり、物体側から順に、第１レンズ群Ｇｒ１，第２レンズ群Ｇｒ２，第３レンズ群Ｇｒ３及び第４レンズ群Ｇｒ４から構成され、正負正正４成分ズームでＧｒ１，Ｇｒ３固定、Ｇｒ２，Ｇｒ４可動のタイプである。尚、Ｇｒ１は３枚のレンズＧ１，Ｇ２，Ｇ３から成り、Ｇｒ２は３枚のレンズＧ４，Ｇ５，Ｇ６から成り、Ｇｒ３は２枚のレンズＧ１及びＧ２並びに絞りＳから成り、Ｇｒ４は３枚のレンズＧ９，Ｇ１０，Ｇ１１から成る。また、像側端部の平行平板はローパスフィルターＬＰＦである。

【００１５】第１の実施形態の内、図２に示す構成は、主光学系Ｌ１とＬＰＦとの間に変換光学系Ａ１を配置した光学系で第２画面サイズ（大きい画面サイズ，光軸と垂直な方向の高さＹ＝４．０ｍｍ）に対応している。尚、Ａ１は２枚のレンズＧ１２，Ｇ１３から成る。

【００１６】第２の実施形態の内、図３に示す構成は、主光学系Ｌ２のみで第１画面サイズ（小さい画面サイズ，光軸と垂直な方向の高さＹ＝３．１ｍｍ）に対応している。同図の左側が物体側、右側が像側である。また、主光学系Ｌ２はズームレンズであり、物体側から順に、第１レンズ群Ｇｒ１，第２レンズ群Ｇｒ２，第３レンズ群Ｇｒ３及び第４レンズ群Ｇｒ４から構成され、第１の実施形態と同様に正負正正４成分ズームでＧｒ１，Ｇｒ３固定、Ｇｒ２，Ｇｒ４可動のタイプである。尚、Ｇｒ１は３枚のレンズＧ１，Ｇ２，Ｇ３から成り、Ｇｒ２は３枚のレンズＧ４，Ｇ５，Ｇ６から成り、Ｇｒ３は

２枚のレンズＧ１及びＧ２並びに絞りＳから成り、Ｇｒ４は３枚のレンズＧ９，Ｇ１０，Ｇ１１から成る。また、像側端部の平行平板はローパスフィルターＬＰＦである。

【００１７】第２の実施形態の内、図４に示す構成は、主光学系Ｌ２とＬＰＦとの間に変換光学系Ａ２を配置した光学系で第２画面サイズ（大きい画面サイズ，光軸と垂直な方向の高さＹ＝４．０mm）に対応している。尚、Ａ２は２枚のレンズＧ１２，Ｇ１３から成る。

【００１８】第３の実施形態の内、図５に示す構成は、主光学系Ｌ３のみで第１画面サイズ（小さい画面サイズ，光軸と垂直な方向の高さＹ＝３．１mm）に対応している。同図の左側が物体側、右側が像側である。また、主光学系Ｌ３はズームレンズであり、物体側から順に、第１レンズ群Ｇｒ１，第２レンズ群Ｇｒ２，第３レンズ群Ｇｒ３及び第４レンズ群Ｇｒ４から構成され、第１の実施形態と同様に正負正正４成分ズームでＧｒ１，Ｇｒ３固定、Ｇｒ２，Ｇｒ４可動のタイプである。尚、Ｇｒ１は３枚のレンズＧ１，Ｇ２，Ｇ３から成り、Ｇｒ２は３枚のレンズＧ４，Ｇ５，Ｇ６から成り、Ｇｒ３は２枚のレンズＧ１及びＧ２並びに絞りＳから成り、Ｇｒ４は３枚のレンズＧ９，Ｇ１０，Ｇ１１から成る。また、像側端部の平行平板はローパスフィルターＬＰＦである。

【００１９】第３の実施形態の内、図６に示す構成は、主光学系Ｌ３とＬＰＦとの間に変換光学系Ａ３を配置した光学系で第２画面サイズ（大きい画面サイズ，光軸と垂直な方向の高さＹ＝４．０mm）に対応している。尚、Ａ３は２枚のレンズＧ１２，Ｇ１３から成る。

【００２０】第４の実施形態の内、図７に示す構成は、主光学系Ｌ４のみで第１画面サイズ（小さい画面サイズ，光軸と垂直な方向の高さＹ＝３．１mm）に対応している。同図の左側が物体側、右側が像側である。また、主光学系Ｌ４はズームレンズであり、物体側から順に、第１レンズ群Ｇｒ１，第２レンズ群Ｇｒ２，第３レンズ群Ｇｒ３及び第４レンズ群Ｇｒ４から構成され、第１の実施形態と同様に正負正正４成分ズームでＧｒ１，Ｇｒ３固定、Ｇｒ２，Ｇｒ４可動のタイプである。尚、Ｇｒ１は３枚のレンズＧ１，Ｇ２，Ｇ３から成り、Ｇｒ２は３枚のレンズＧ４，Ｇ５，Ｇ６から成り、Ｇｒ３は２枚のレンズＧ１及びＧ２並びに絞りＳから成り、Ｇｒ＊４は３枚のレンズＧ９，Ｇ１０，Ｇ１１から成る。また、像側端部の平行平板はローパスフィルターＬＰＦである。

【００２１】第４の実施形態の内、図８に示す構成は、主光学系Ｌ４とＬＰＦとの間に変換光学系Ａ４を配置した光学系で第２画面サイズ（大きい画面サイズ，光軸と垂直な方向の高さＹ＝４．０mm）に対応している。尚、Ａ４は２枚のレンズＧ１２，Ｇ１３から成る。

【００２２】第５の実施形態の内、図９に示す構成は、主光学系Ｌ５のみで第１画面サイズ（小さい画面サイズ，光軸と垂直な方向の高さＹ＝２．３mm）に対応している。同図の左側が物体側、右側が像側である。また、主光学系Ｌ５はズームレンズであり、物体側から順に、第１レンズ群Ｇｒ１，第２レンズ群Ｇｒ２，第３レンズ群Ｇｒ３及び第４レンズ群Ｇｒ４から構成され、第１の実施形態と同様に正負正正４成分ズームでＧｒ１，Ｇｒ３固定、Ｇｒ２，Ｇｒ４可動のタイプである。尚、Ｇｒ１は３枚のレンズＧ１，Ｇ２，Ｇ３から成り、Ｇｒ２は３枚のレンズＧ４，Ｇ５，Ｇ６から成り、Ｇｒ３は２枚のレンズＧ１及びＧ２並びに絞りＳから成り、Ｇｒ４は３枚のレンズＧ９，Ｇ１０，Ｇ１１から成る。また、像側端部の平行平板はローパスフィルターＬＰＦである。

【００２３】第５の実施形態の内、図１０に示す構成は、主光学系Ｌ５とＬＰＦとの間に変換光学系Ａ５を配置した光学系で第２画面サイズ（大きい画面サイズ，光軸と垂直な方向の高さＹ＝４．０mm）に対応している。尚、Ａ５は２枚のレンズＧ１２，Ｇ１３から成る。

【００２４】通常、同じ仕様であれば第２画面サイズの光学系の方が第１画面サイズの光学系よりも大きくなる。故に、画面サイズを変換する場合、第２画面サイズの光学系に変換光学系を配置して第１画面サイズの光学系に変換すると、その変換後の光学系は、第１画面サイズの光学系としては過度に大きな光学系となる。従って、上記各実施形態のように、第１画面サイズの光学系に変換光学系を配置して第２画面サイズの光学系に変換する方が、光学系を小型化する事ができ、大きさに関して非常に有利である。

【００２５】以下に、光学系について望ましい条件を記す。上記各実施形態の内、第２画面サイズの光学系は、以下の条件式（１）を満足する事が望ましい。

$$2.5 < |fc/Yb| < 11.0 \quad (1)$$

但し、

ｆｃ：変換光学系の焦点距離

Ｙｂ：第２画面サイズの最大像高

である。

【００２６】条件式（１）は、変換光学系の焦点距離を規定する式である。この条件式の下限値以下になると、変換光学系の焦点距離が短くなり、即ちパワーが強くなり過ぎるため、諸収差の中でも特に樽型の歪曲収差、及び像面湾曲の補正が困難となる。逆に、上限値以上になると、変換光学系の焦点距離が長くなり、即ちパワーが弱くなり過ぎるため、拡大倍率を確保する事が困難となり、変換光学系配置前後での焦点距離があまり変化せず、第２画面サイズの光学系にとっては広角側になるため、周辺性能、特に像面湾曲の補正が困難となる。

【００２７】また、各実施形態の内、第２画面サイズの光学系は、以下の条件式（２）を満足する事が望まし

い。

$$1.1<\beta c<1.9 \qquad (2)$$

但し、
βc：変換光学系の横倍率
である。

【００２８】条件式（２）は、変換光学系の倍率を規定する式である。この条件式の下限値以下になると、変換倍率が小さくなり過ぎ、変換光学系を配置した際の焦点距離が拡大されないため、広角側になり、像面湾曲の補正が困難となる。逆に、上限値以上になると、変換倍率が大きくなり過ぎ、諸収差の中でも特に樽型の歪曲収差、及び像面湾曲の補正が困難となる。

【００２９】また、各実施形態の光学系は、以下の条件式（３）を満足する事が望ましい。

$$0.7<(Yb/Ys)/\beta c<1.3 \qquad (3)$$

但し、
Ｙｓ：第１画面サイズの最大像高
である。

【００３０】条件式（３）は、画面サイズの比と変換倍率との関係を規定する式であり、変換光学系の前後で画角がほぼ等しくなる事を意味している。この条件式の範囲を逸脱すると、変換光学系配置前後での画角の変化が大きくなり、共通で使用する主光学系の画角に対する負担が大きくなるため、全長，前玉径の増加、収差劣化に伴うレンズ枚数の増加を招く。具体的には、条件式の下限値以下になると、変換光学系配置後の焦点距離が望遠側にシフトし過ぎるため、レンズ系全長の増加及び球面収差の劣化を招く。逆に、上限値以上になると、配置後の焦点距離が広角側にシフトし過ぎるため、前玉径の増加，像面湾曲，及び歪曲収差の劣化を招く。

【００３１】また、各実施形態の内、第１画面サイズの光学系は、以下の条件式（４）を満足する事が望ましい。

$$1.0<|f2|/fws<1.8 \qquad (4)$$

但し、
ｆ２　：第２レンズ群の焦点距離
ｆｗｓ：第１画面サイズの光学系の、広角端での全系の焦点距離
である。

【００３２】この条件式の下限値以下になると、第２レンズ群の焦点距離が短くなり過ぎ、即ち第２レンズ群のパワーが強くなり過ぎるので、第１画面サイズの光学系及び変換光学系を配置した第２画面サイズの光学系のいずれにおいても、広角端での負の歪曲収差の補正が困難になるとともに、像面湾曲のアンダー側への倒れが著しくなる。逆に、上限値以上になると、第２レンズ群の変倍の際の移動量が増大し、それに伴い前玉径の増大を招く。

【００３３】尚、各実施形態では、主光学系の構成を全く変化させずに変換光学系を付加して画面サイズを変換する例を示したが、本発明はこれに限定されない。例えば、主光学系の主要な特性を変更させずに構成の一部を変更した上で、変換光学系を付加しても良い。主光学系の主要な特性を変更させない例としては、主光学系を構成する単レンズ素子のパワーを変化させずに曲率半径を変更するいわゆるベンディングや、非球面や回折光学面の付加等が挙げられる。また、主光学系に、像面性能補正用のために、それぞれ弱いパワーの球面レンズ，接合レンズ，非球面レンズ，回折光学レンズ等を付加する事も、主光学系の主要な特性を変更させない例の範疇である。

【００３４】特に、大きい画面サイズに対応する場合、光電変換素子の画素数が大きくなり、小さい画面サイズの場合よりも光学性能を向上させる必要があるため、上記のような主光学系の一部の変更は、光学性能向上の観点から有効である。また、各実施形態では、主光学系，変換光学系共、全て屈折面で構成される例を示したが、撮像装置の事情に応じて、光路中にミラーを配置して光路を折り曲げる構成や、回折光学素子を用いる構成等を採用しても良い。

【００３５】さらに、各実施形態では、異なるサイズの光電変換素子に対応可能な撮影光学系の例を示したが、例えば、小さい画面サイズの光電変換素子と大きい画面サイズの銀塩フィルムに対応する撮影光学系や、従来の３５ｍｍ銀塩フィルムと新規格の銀塩フィルム（いわゆる Advanced Photo system，ＡＰＳフォーマット）に対応する撮影光学系等に対しても、各実施形態の技術は適用可能である。

【００３６】以下、本発明に係る撮影光学系の構成を、コンストラクションデータ，収差図等を挙げて、更に具体的に示す。尚、以下に挙げる実施例１～５の第１画面サイズ及び第２画面サイズの光学系は、前述した第１～第５の実施形態の第１画面サイズ及び第２画面サイズの光学系にそれぞれ対応しており、第１～第５の実施形態の撮影光学系（第１画面サイズ及び第２画面サイズ）を表すレンズ構成図（図１～図１０）は、対応する実施例１～５の第１画面サイズ及び第２画面サイズの光学系のレンズ構成をそれぞれ示している。

【００３７】各実施例において、ri(i=1,2,3...)は、物体側から数えてi 番目の面及びその曲率半径を示し、di(i=1,2,3...)は、物体側から数えてi 番目の軸上面間隔を示し、Ni(i=1,2,3...)，νi(i=1,2,3...) は、それぞれ物体側から数えてi 番目のレンズのｄ線に対する屈折率，アッベ数を示す。また、実施例中の全系の焦点距離ｆ，及び全系のＦナンバーＦＮＯ、並びに第１レンズ群と第２レンズ群との間隔，第２レンズ群と第３レンズ群

との間隔，第３レンズ群と第４レンズ群との間隔，及び主光学系最終レンズ群とＬＰＦ或いは変換光学系との間隔は、左から順に、広角端（W），中間焦点距離（M），望遠端（T）でのそれぞれの値に対応している。尚、各実施例中、曲率半径に＊印を付した面は、非球面で構成された面である事を示し、非球面の面形状を表す式は、以下に定義する。

【００３８】

$$X = X_0 + \Sigma A_i Y^i \quad \cdots\cdots (a)$$

$$X_0 = CY^2 / \{1 + (1 - \varepsilon C^2 Y^2)^{1/2}\} \quad \cdots\cdots (b)$$

但し、

X ：光軸方向の基準面からの変位量

Y ：光軸と垂直な方向の高さ

C ：近軸曲率

ε ：２次曲面パラメータ

A_i ：ｉ次の非球面係数

である。

【００３９】

《実施例１（第１画面サイズ）》

f =5.1mm ～12.0mm～29.4mm （全系焦点距離）

FNO=2.28 ～2.51 ～2.88 （Ｆナンバー）

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1= 39.361			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 25.444			
	d2= 3.932	N2=1.48749	ν2= 70.44
r3= -92.731			
	d3= 0.100		
r4= 18.735			
	d4= 1.976	N3=1.65364	ν3= 55.78
r5= 35.205			
	d5= 0.500 ～ 8.755 ～14.831		
r6*= 49.390			
	d6= 0.750	N4=1.77250	ν4= 49.77
r7*= 7.170			
	d7= 4.459		
r8= -9.753			
	d8= 0.700	N5=1.48749	ν5= 70.44
r9= 12.601			
	d9= 1.268	N6=1.83350	ν6= 21.00
r10= 57.770			
	d10=14.831 ～ 6.576 ～ 0.500		
r11= ∞（絞り）			
	d11= 0.500		
r12= 15.739			
	d12= 1.546	N7=1.75450	ν7= 51.57
r13=-113.832			
	d13= 1.000	N8=1.84666	ν8= 23.82
r14*=41.438			
	d14= 4.732 ～ 2.453 ～ 0.200		
r15= 6.813			
	d15= 3.315	N9=1.63237	ν9= 48.67
r16=-34.984			
	d16= 1.181		
r17*=-49.645			
	d17= 1.000	N10=1.84666	ν10= 23.82
r18*= 9.148			
	d18= 1.869		

r19= 11.635
d19= 2.378 N11=1.54012 ν11= 63.99
r20=-15.552
d20= 1.359 ～ 3.641 ～ 5.877
r21= ∞
d21= 3.400 N12=1.51680 ν12= 64.20
r22= ∞

【００４０】

[第６面(r6)の非球面係数]
ε = 0.10000×10
A4= 0.26307×10^{-4}
A6= 0.24482×10^{-5}
A8=-0.30163×10^{-7}

[第７面(r7)の非球面係数]
ε = 0.10000×10
A4=-0.92198×10^{-5}
A6= 0.24720×10^{-5}
A8= 0.22450×10^{-6}

[第１４面(r14)の非球面係数]
ε = 0.10000×10
A4= 0.30309×10^{-4}
A6= 0.27800×10^{-5}
A8=-0.29431×10^{-6}
A10= 0.11555×10^{-7}

[第１７面(r17)の非球面係数]
ε = 0.10000×10
A4=-0.47983×10^{-3}
A6= 0.34008×10^{-5}
A8=-0.15789×10^{-6}

[第１８面(r18)の非球面係数]
ε = 0.10000×10
A4= 0.49212×10^{-3}
A6= 0.16988×10^{-4}
A8= 0.50803×10^{-6}

【００４１】

《実施例１（第２画面サイズ）》
f =6.6mm ～15.5mm～38.1mm （全系焦点距離）
FNO=2.93 ～3.24 ～3.72 （Ｆナンバー）
[曲率半径] [軸上面間隔] [屈折率(Nd)] [アッベ数(νd)]
r1= 39.361
d1= 0.800 N1=1.83350 ν1= 21.00
r2= 25.444
d2= 3.932 N2=1.48749 ν2= 70.44
r3= -92.731
d3= 0.100
r4= 18.735
d4= 1.976 N3=1.65364 ν3= 55.78
r5= 35.205
d5= 0.500 ～ 8.755 ～14.831
r6*= 49.390

d6= 0.750 N4=1.77250 ν4= 49.77
r7*= 7.170
d7= 4.459
r8= -9.753
d8= 0.700 N5=1.48749 ν5= 70.44
r9= 12.601
d9= 1.268 N6=1.83350 ν6= 21.00
r10= 57.770
d10=14.831 ～ 6.576 ～ 0.500
r11= ∞（絞り）
d11= 0.500
r12= 15.739
d12= 1.546 N7=1.75450 ν7= 51.57
r13=-113.832
d13= 1.000 N8=1.84666 ν8= 23.82
r14*=41.438
d14= 4.732 ～ 2.453 ～ 0.200
r15= 6.813
d15= 3.315 N9=1.63237 ν9= 48.67
r16=-34.984
d16= 1.181
r17*=-49.645
d17= 1.000 N10=1.84666 ν10= 23.82
r18*= 9.148
d18= 1.869
r19= 11.635
d19= 2.378 N11=1.54012 ν11= 63.99
r20=-15.552
d20= 0.400 ～ 2.679 ～ 4.932
r21= 71.678
d21= 0.800 N12=1.75450 ν12= 51.57
r22= 6.056
d22= 0.121
r23= 6.248
d23= 2.244 N13=1.57058 ν13= 39.32
r24= 33.647
d24= 1.000
r25= ∞
d25= 3.400 N14=1.51680 ν14= 64.20
r26= ∞

【００４２】

[第６面(r6)の非球面係数]
ε = 0.10000×10
A4= 0.26307×10^{-4}
A6= 0.24482×10^{-5}
A8= -0.30163×10^{-7}

[第７面(r7)の非球面係数]
ε = 0.10000×10
A4= -0.92198×10^{-5}
A6= 0.24720×10^{-5}

A8= 0.22450×10^{-6}

［第１４面(r14)の非球面係数］

ε = 0.10000×10

A4= 0.30309×10^{-4}

A6= 0.27800×10^{-5}

A8= -0.29431×10^{-6}

A10= 0.11555×10^{-7}

［第１７面(r17)の非球面係数］

ε = 0.10000×10

A4= -0.47983×10^{-3}

A6= 0.34008×10^{-5}

A8= -0.15789×10^{-6}

［第１８面(r18)の非球面係数］

ε = 0.10000×10

A4= 0.49212×10^{-3}

A6= 0.16988×10^{-4}

A8= 0.50803×10^{-6}

【００４３】

《実施例２（第１画面サイズ）》

f =5.1mm ～12.0mm～29.4mm （全系焦点距離）

FNO=2.28 ～2.51 ～2.88 （Ｆナンバー）

［曲率半径］［軸上面間隔］［屈折率(Nd)］［アッベ数(νd)］

［曲率半径］	［軸上面間隔］	［屈折率(Nd)］	［アッベ数(νd)］
r1= 44.384			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 26.902			
	d2= 3.548	N2=1.48749	ν2= 70.44
r3= -87.224			
	d3= 0.100		
r4= 18.690			
	d4= 1.903	N3=1.71785	
r5= 34.111			
	d5= 0.500 ～ 8.898 ～15.092		
r6*= 53.697			
	d6= 0.750	N4=1.77250	ν3= 49.77
r7*= 7.151			
	d7= 4.412		
r8= -9.136			
	d8= 0.700	N5=1.48749	
r9= 14.748			
	d9= 1.249	N6=1.83350	ν4= 21.00
r10=166.857			
	d10=15.092 ～ 6.694 ～ 0.500		
r11= ∞（絞り）			
	d11= 0.500		
r12= 16.402			
	d12= 1.569	N7=1.75450	
r13=-73.572			
	d13= 1.000	N8=1.84666	ν5= 23.82
r14*=47.167			
	d14= 4.771 ～ 2.465 ～ 0.200		

r15= 6.930
d15= 3.195 N9=1.64598
r16=-49.092
d16= 1.247
r17*=-259.880
d17= 1.000 N10=1.84666 ν6= 23.82
r18*= 8.606
d18= 2.029
r19= 10.973
d19= 2.385 N11=1.48757
r20=-15.859
d20= 1.336 ～ 3.642 ～ 5.907
ｒ２１＝ ∞
d21= 3.400 N12=1.51680 ν7= 64.20
r22= ∞

【００４４】

[第６面(r6)の非球面係数]
ε = 0.10000×10
A4= 0.50768×10^{-4}
A6= 0.27040×10^{-5}
A8=-0.32896×10^{-7}
[第７面(r7)の非球面係数]
ε = 0.10000×10
A4=-0.26886×10^{-5}
A6= 0.24656×10^{-5}
A8= 0.28044×10^{-6}
[第１４面(r14)の非球面係数]
ε = 0.10000×10
A4= 0.29944×10^{-4}
A6= 0.23942×10^{-5}
A8=-0.26510×10^{-6}
A10= 0.10143×10^{-7}
[第１７面(r17)の非球面係数]
ε = 0.10000×10
A4=-0.43785×10^{-3}
A6=-0.85525×10^{-6}
A8=-0.55200×10^{-7}
[第１８面(r18)の非球面係数]
ε = 0.10000×10
A4= 0.49210×10^{-3}
A6= 0.12730×10^{-4}
A8= 0.66578×10^{-6}

【００４５】

《実施例２（第２画面サイズ）》
f =6.6mm ～15.5mm～38.1mm （全系焦点距離）
FNO=2.9 ～3.22 ～3.72 （Ｆナンバー）
[曲率半径] [軸上面間隔] [屈折率(Nd)] [アッベ数(νd)]
r1= 44.384
d1= 0.800 N1=1.83350 ν1= 21.00
r2= 26.902

d2= 3.548　N2=1.48749
r3= -87.224
d3= 0.100
r4= 18.690
d4= 1.903　N3=1.71785
r5= 34.111
d5= 0.500 ～ 8.898 ～15.092
r6*= 53.697
d6= 0.750　N4=1.77250　ν2= 49.77
r7*= 7.151
d7= 4.412
r8= -9.136
d8= 0.700　N5=1.48749
r9= 14.748
d9= 1.249　N6=1.83350　ν3= 21.00
r10=166.857
d10=15.092 ～ 6.694 ～ 0.500
r11= ∞（絞り）
d11= 0.500
r12= 16.402
d12= 1.569　N7=1.75450
r13=-73.572
d13= 1.000　N8=1.84666　ν4= 23.82
r14*=47.167
d14= 4.771 ～ 2.465 ～ 0.200
r15= 6.930
d15= 3.195　N9=1.64598
r16=-49.092
d16= 1.247
r17*=-259.880
d17= 1.000　N10=1.84666　ν5= 23.82
r18*= 8.606
d18= 2.029
r19= 10.973
d19= 2.385　N11=1.48757
r20=-15.859
d20= 0.100 ～ 2.405 ～ 4.671
r21= 49.436
d21= 0.600　N12=1.75450
r22= 5.976
d22= 0.102
r23= 6.145
d23= 1.807　N13=1.57277
r24= 28.181
d24= 1.000
r25= ∞
d25= 3.400　N14=1.51680　ν6= 64.20
r26= ∞

【００４６】

［第６面(r6)の非球面係数］

ε= 0.10000×10
A4= 0.50768×10^{-4}
A6= 0.27040×10^{-5}
A8=-0.32896×10^{-7}
[第７面(r7)の非球面係数]
ε= 0.10000×10
A4=-0.26886×10^{-5}
A6= 0.24656×10^{-5}
A8= 0.28044×10^{-6}
[第１４面(r14)の非球面係数]
ε= 0.10000×10
A4= 0.29944×10^{-4}
A6= 0.23942×10^{-5}
A8=-0.26510×10^{-6}
A10= 0.10143×10^{-7}
[第１７面(r17)の非球面係数]
ε= 0.10000×10
A4=-0.43785×10^{-3}
A6=-0.85525×10^{-6}
A8=-0.55200×10^{-7}
[第１８面(r18)の非球面係数]
ε= 0.10000×10
A4= 0.49210×10^{-3}
A6= 0.12730×10^{-4}
A8= 0.66578×10^{-6}

【００４７】

《実施例３（第１画面サイズ）》
f =5.1mm ～12.0mm～29.4mm （全系焦点距離）
FNO=2.28 ～2.51 ～2.88 （Ｆナンバー）

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1= 38.100			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 25.197			
	d2= 4.072	N2=1.48749	ν2= 70.44
r3= -98.604			
	d3= 0.100		
r4= 19.021			
	d4= 2.041	N3=1.63412	ν3= 56.85
r5= 36.020			
	d5= 0.500 ～ 8.861 ～14.981		
r6*= 49.673			
	d6= 0.750	N4=1.77250	ν4= 49.77
r7*= 7.233			
	d7= 4.595		
r8= -9.793			
	d8= 0.700	N5=1.48749	ν5= 70.44
r9= 12.800			
	d9= 1.273	N6=1.83350	ν6= 21.00
r10= 60.435			
	d10=14.981 ～ 6.620 ～ 0.500		

r11= ∞（絞り）

d11= 0.500

r12= 15.868

d12= 1.517　N7=1.75450　ν7= 51.57

r13=-296.209

d13= 1.000　N8=1.84666　ν8= 23.82

r14*=35.961

d14= 4.773 ～ 2.488 ～ 0.200

r15= 6.619

d15= 3.473　N9=1.56380　ν9= 47.92

r16=-24.792

d16= 1.309

r17*=-23.223

d17= 1.000　N10=1.84666　ν10= 23.82

r18*=11.411

d18= 1.585

r19= 12.595

d19= 2.498　N11=1.58242　ν11= 60.28

r20=-13.465

d20= 1.343 ～ 3.628 ～ 5.916

r21= ∞

d21= 3.400　N12=1.51680　ν12= 64.20

r22= ∞

【００４８】

[第６面(r6)の非球面係数]

ε = 0.10000×10

A4= 0.29472×10^{-4}

A6= 0.19378×10^{-5}

A8= -0.23877×10^{-7}

[第７面(r7)の非球面係数]

ε = 0.10000×10

A4= -0.60653×10^{-5}

A6= 0.20752×10^{-5}

A8= 0.17680×10^{-6}

[第１４面(r14)の非球面係数]

ε = 0.10000×10

A4= 0.32613×10^{-4}

A6= 0.21765×10^{-5}

A8= -0.22337×10^{-6}

A10= 0.89525×10^{-8}

[第１７面(r17)の非球面係数]

ε = 0.10000×10

A4= -0.50533×10^{-3}

A6= 0.65302×10^{-5}

A8= -0.26699×10^{-6}

[第１８面(r18)の非球面係数]

ε = 0.10000×10

A4= 0.46260×10^{-3}

A6= 0.18637×10^{-4}

A8= 0.25741×10^{-6}

【００４９】

《実施例３（第２画面サイズ）》

f =7.3mm ～17.2mm～42.0mm　（全系焦点距離）

FNO=3.26　～3.58　～4.12　　（Ｆナンバー）

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1= 38.100			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 25.197			
	d2= 4.072	N2=1.48749	ν2= 70.44
r3= -98.604			
	d3= 0.100		
r4= 19.021			
	d4= 2.041	N3=1.63412	ν3= 56.85
r5= 36.020			
	d5= 0.500 ～ 8.861 ～14.981		
r6*= 49.673			
	d6= 0.750	N4=1.77250	ν4= 49.77
r7*= 7.233			
	d7= 4.595		
r8= -9.793			
	d8= 0.700	N5=1.48749	ν5= 70.44
r9= 12.800			
	d9= 1.273	N6=1.83350	ν6= 21.00
r10= 60.435			
	d10=14.981 ～ 6.620 ～ 0.500		
r11= ∞（絞り）			
	d11= 0.500		
r12= 15.868			
	d12= 1.517	N7=1.75450	ν7= 51.57
r13=-296.209			
	d13= 0.010		
r14=-296.203			
	d14= 1.000	N8=1.84666	ν8= 23.82
r15*=35.961			
	d15= 4.773 ～ 2.488 ～ 0.200		
r16= 6.619			
	d16= 3.473	N9=1.56380	ν9= 47.92
r17=-24.792			
	d17= 1.309		
r18*=-23.223			
	d18= 1.000	N10=1.84666	ν10= 23.82
r19*=11.411			
	d19= 1.585		
r20= 12.595			
	d20= 2.498	N11=1.58242	ν11= 60.28
r21=-13.465			
	d21= 0.400 ～ 2.685 ～ 4.973		
r22= 41.840			
	d22= 0.800	N12=1.75450	ν12= 51.57
r23= 5.885			

d23= 0.245

r24= 6.199

d24= 2.016 N13=1.59891 ν13= 35.03

r25= 16.340

d25= 1.000

r26= ∞

d26= 3.400 N14=1.51680 ν14= 64.20

r27= ∞

【００５０】

[第６面(r6)の非球面係数]

$\varepsilon = 0.10000 \times 10$

$A4 = 0.29472 \times 10^{-4}$

$A6 = 0.19378 \times 10^{-5}$

$A8 = -0.23877 \times 10^{-7}$

[第７面(r7)の非球面係数]

$\varepsilon = 0.10000 \times 10$

$A4 = -0.60653 \times 10^{-5}$

$A6 = 0.20752 \times 10^{-5}$

$A8 = 0.17680 \times 10^{-6}$

[第１５面(r15)の非球面係数]

$\varepsilon = 0.10000 \times 10$

$A4 = 0.32613 \times 10^{-4}$

$A6 = 0.21765 \times 10^{-5}$

$A8 = -0.22337 \times 10^{-6}$

$A10 = 0.89525 \times 10^{-8}$

[第１８面(r18)の非球面係数]

$\varepsilon = 0.10000 \times 10$

$A4 = -0.50533 \times 10^{-3}$

$A6 = 0.65302 \times 10^{-5}$

$A8 = -0.26699 \times 10^{-6}$

[第１９面(r19)の非球面係数]

$\varepsilon = 0.10000 \times 10$

$A4 = 0.46260 \times 10^{-3}$

$A6 = 0.18637 \times 10^{-4}$

$A8 = 0.25741 \times 10^{-6}$

【００５１】

《実施例４（第１画面サイズ）》

f =5.1mm ～12.0mm～29.4mm （全系焦点距離）

FNO=2.3 ～2.53 ～2.88 （Ｆナンバー）

[曲率半径] [軸上面間隔] [屈折率(Nd)] [アッベ数(νd)]

r1= 51.292

d1= 0.800 N1=1.83350 ν1= 21.00

r2= 28.707

d2= 3.874 N2=1.49411 ν2= 69.48

r3= -88.318

d3= 0.100

r4= 19.533

d4= 2.187 N3=1.74575 ν3= 51.87

r5= 38.766

d5= 0.500 ～ 8.903 ～15.126

r6*= 76.536
d6= 0.750 N4=1.77250 ν4= 49.77
r7*= 7.248
d7= 4.289
r8= -9.577
d8= 0.700 N5=1.48749 ν5= 70.44
r9= 14.103
d9= 1.327 N6=1.83350 ν6= 21.00
r10=119.341
d10=15.126 ～ 6.723 ～ 0.500
r11= ∞ (絞り)
d11= 0.500
r12= 14.886
d12= 1.645 N7=1.76163 ν7= 50.36
r13=-54.790
d13= 1.000 N8=1.84666 ν8= 23.82
r14*=47.323
d14= 4.717 ～ 2.400 ～ 0.200
r15= 7.049
d15= 3.069 N9=1.65030 ν9= 49.41
r16=-87.401
d16= 1.297
r17*=107.653
d17= 1.000 N10=1.84666 ν10= 23.82
r18*= 7.817
d18= 1.736
r19= 10.410
d19= 2.338 N11=1.48749 ν11= 70.44
r20=-16.932
d20= 1.351 ～ 3.667 ～ 5.867
r21= ∞
d21= 3.400 N12=1.51680 ν12= 64.20
r22= ∞

【００５２】

[第６面(r6)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.15037\times10^{-3}$
$A6=-0.41303\times10^{-6}$
$A8=-0.67332\times10^{-8}$

[第７面(r7)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.11096\times10^{-3}$
$A6= 0.25794\times10^{-5}$
$A8= 0.16455\times10^{-6}$

[第１４面(r14)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.30579\times10^{-4}$
$A6= 0.34943\times10^{-5}$
$A8=-0.41149\times10^{-6}$
$A10= 0.16505\times10^{-7}$

［第１７面(r17)の非球面係数］

ε= 0.10000×10

A4=-0.46605×10^{-3}

A6= 0.42583×10^{-6}

A8=-0.17528×10^{-8}

［第１８面(r18)の非球面係数］

ε= 0.10000×10

A4= 0.39333×10^{-3}

A6= 0.12845×10^{-4}

A8= 0.65431×10^{-6}

【００５３】

《実施例４（第２画面サイズ）》

f =6.0mm ～14.1mm～34.6mm （全系焦点距離）

FNO=2.73 ～3.0 ～3.4 （Ｆナンバー）

［曲率半径］［軸上面間隔］［屈折率(Nd)］［アッベ数(νd)］

r1= 51.292			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 28.707			
	d2= 3.874	N2=1.49411	ν2= 69.48
r3= -88.318			
	d3= 0.100		
r4= 19.533			
	d4= 2.187	N3=1.74575	ν3= 51.87
r5= 38.766			
	d5= 0.500 ～ 8.903 ～15.126		
r6*= 76.536			
	d6= 0.750	N4=1.77250	ν4= 49.77
r7*= 7.248			
	d7= 4.289		
r8= -9.577			
	d8= 0.700	N5=1.48749	ν5= 70.44
r9= 14.103			
	d9= 1.327	N6=1.83350	ν6= 21.00
r10=119.341			
	d10=15.126 ～ 6.723 ～ 0.500		
r11= ∞（絞り）			
	d11= 0.500		
r12= 14.886			
	d12= 1.645	N7=1.76163	ν7= 50.36
r13=-54.790			
	d13= 1.000	N8=1.84666	ν8= 23.82
r14*=47.323			
	d14= 4.717 ～ 2.400 ～ 0.200		
r15= 7.049			
	d15= 3.069	N9=1.65030	ν9= 49.41
r16=-87.401			
	d16= 1.297		
r17*=107.653			
	d17= 1.000	N10=1.84666	ν10= 23.82
r18*= 7.817			

d18= 1.736
r19= 10.410
d19= 2.338 N11=1.48749 ν11= 70.44
r20=-16.932
d20= 0.400 ～ 2.717 ～ 4.917
r21=117.244
d21= 0.800 N12=1.75450 ν12= 51.57
r22= 6.400
d22= 0.100
r23= 6.592
d23= 2.286 N13=1.64387 ν13= 44.47
r24=45.168
d24= 1.000
r25= ∞
d25= 3.400 N14=1.51680 ν14= 64.20
r26= ∞

【００５４】

［第６面(r6)の非球面係数］
ε = 0.10000×10
A4= 0.15037×10^{-3}
A6=-0.41303×10^{-6}
A8=-0.67332×10^{-8}

［第７面(r7)の非球面係数］
ε = 0.10000×10
A4= 0.11096×10^{-3}
A6= 0.25794×10^{-5}
A8= 0.16455×10^{-6}

［第１４面(r14)の非球面係数］
ε = 0.10000×10
A4= 0.30579×10^{-4}
A6= 0.34943×10^{-5}
A8=-0.41149×10^{-6}
A10= 0.16505×10^{-7}

［第１７面(r17)の非球面係数］
ε = 0.10000×10
A4=-0.46605×10^{-3}
A6= 0.42583×10^{-6}
A8=-0.17528×10^{-8}

［第１８面(r18)の非球面係数］
ε = 0.10000×10
A4= 0.39333×10^{-3}
A6= 0.12845×10^{-4}
A8= 0.65431×10^{-6}

【００５５】

《実施例５（第１画面サイズ）》
f =3.8mm～9.0mm～21.7mm （全系焦点距離）
FNO=2.34 ～2.52 ～2.88 （Ｆナンバー）
［曲率半径］［軸上面間隔］［屈折率(Nd)］［アッベ数(νd)］
r1= 33.893
d1= 0.800 N1=1.83350 ν1= 21.00

r2= 20.854
　d2= 2.933　N2=1.48749　ν2= 70.44
r3=3458.532
　d3= 0.100
r4= 18.532
　d4= 2.028　N3=1.75409　ν3= 51.58
r5= 52.594
　d5= 0.500 ～ 7.990 ～13.134
r6*= 54.228
　d6= 0.750　N4=1.77250　ν4= 49.77
r7*= 5.734
　d7= 3.716
r8= -9.442
　d8= 0.700　N5=1.51435　ν5= 54.87
r9= 10.231
　d9= 1.262　N6=1.83350　ν6= 21.00
r10= 82.356
　d10=13.134 ～ 5.644 ～ 0.500
r11= ∞（絞り）
　d11= 0.500
r12= 12.294
　d12= 1.696　N7=1.70084　ν7= 26.54
r13=-12.693
　d13= 1.000　N8=1.84666　ν8= 23.82
r14*=22.033
　d14= 3.925 ～ 2.101 ～ 0.200
r15= 6.741
　d15= 5.913　N9=1.50423　ν9= 59.67
r16= -9.980
　d16= 1.116
r17*=-6.796
　d17= 1.000　N10=1.84666　ν10= 23.82
r18*=-127.113
　d18= 0.100
r19= 12.962
　d19= 3.236　N11=1.61322　ν11= 48.97
r20= -7.908
　d20= 1.731 ～ 3.554 ～ 5.455
r21= ∞
　d21= 3.400　N12=1.51680　ν12= 64.20
r22= ∞

【００５６】

[第６面(r6)の非球面係数]
ε = 0.10000×10
A4= 0.17992×10^{-3}
A6= 0.21097×10^{-5}
A8=-0.60366×10^{-7}
[第７面(r7)の非球面係数]
ε = 0.10000×10
A4= 0.10422×10^{-3}

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A6= 0.71873×10^{-5}
A8= 0.67492×10^{-6}
[第１４面(r14)の非球面係数]
ε= 0.10000×10
A4= 0.20982×10^{-4}
A6= 0.10888×10^{-4}
A8= -0.19610×10^{-5}
A10= 0.12639×10^{-6}
[第１７面(r17)の非球面係数]
ε= 0.10000×10
A4= -0.82030×10^{-3}
A6= 0.27014×10^{-4}
A8= -0.40805×10^{-6}
[第１８面(r18)の非球面係数]
ε= 0.10000×10
A4= 0.26263×10^{-3}
A6= 0.42079×10^{-4}
A8= -0.49132×10^{-6}

【００５７】

《実施例５（第２画面サイズ）》
f =6.6mm～15.7mm～37.8mm　(全系焦点距離)
FNO=4.11 ～4.43 ～5.0　(Ｆナンバー)

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1= 33.893			
	d1= 0.800	N1=1.83350	ν1= 21.00
r2= 20.854			
	d2= 2.933	N2=1.48749	ν2= 70.44
r3=3458.532			
	d3= 0.100		
r4= 18.532			
	d4= 2.028	N3=1.75409	ν3= 51.58
r5= 52.594			
	d5= 0.500 ～ 7.990 ～13.134		
r6*= 54.228			
	d6= 0.750	N4=1.77250	ν4= 49.77
r7*= 5.734			
	d7= 3.716		
r8= -9.442			
	d8= 0.700	N5=1.51435	ν5= 54.87
r9= 10.231			
	d9= 1.262	N6=1.83350	ν6= 21.00
r10= 82.356			
	d10=13.134 ～ 5.644 ～ 0.500		
r11= ∞（絞り）			
	d11= 0.500		
r12= 12.294			
	d12= 1.696	N7=1.70084	ν7= 26.54
r13=-12.693			
	d13= 1.000	N8=1.84666	ν8= 23.82
r14*=22.033			

d14= 3.925 ～ 2.101 ～ 0.200
r15= 6.741
d15= 5.913　N9=1.50423　ν9= 59.67
r16= -9.980
d16= 1.116
r17*=-6.796
d17= 1.000　N10=1.84666　ν10= 23.82
r18*=-127.113
d18= 0.100
r19= 12.962
d19= 3.236　N11=1.61322　ν11= 48.97
r20= -7.908
d20= 0.400 ～ 2.224 ～ 4.125
r21= 33.371
d21= 0.800　N12=1.75450　ν12= 51.57
r22= 5.500
d22= 0.660
r23= 6.120
d23= 1.747　N13=1.71069　ν13= 26.02
r24= 8.790
d24= 1.000
r25= ∞
d25= 3.400　N14=1.51680　ν14= 64.20
r26= ∞

【００５８】
[第６面(r6)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.17992\times10^{-3}$
$A6= 0.21097\times10^{-5}$
$A8=-0.60366\times10^{-7}$
[第７面(r7)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.10422\times10^{-3}$
$A6= 0.71873\times10^{-5}$
$A8= 0.67492\times10^{-6}$
[第１４面(r14)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.20982\times10^{-4}$
$A6= 0.10888\times10^{-4}$
$A8=-0.19610\times10^{-5}$
$A10= 0.12639\times10^{-6}$
[第１７面(r17)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4=-0.82030\times10^{-3}$
$A6= 0.27014\times10^{-4}$
$A8=-0.40805\times10^{-6}$
[第１８面(r18)の非球面係数]
$\varepsilon = 0.10000\times10$
$A4= 0.26263\times10^{-3}$
$A6= 0.42079\times10^{-4}$

$A8=-0.49132\times10^{-6}$

【００５９】また、図１１～図２０は、それぞれ前記実施例１～５の第１画面サイズ及び第２画面サイズの光学系に対応する無限遠の収差図であり、各図において、上段は広角端〔W〕、中段は中間焦点距離〔M〕、下段は望遠端〔T〕をそれぞれ表している。そして、球面収差図において、実線（ｄ）はｄ線を表し、破線（ＳＣ）は正弦条件を表している。また、非点収差図において、実線（ＤＳ）と破線（ＤＭ）は、それぞれサジタル面とメリディオナル面での非点収差を表している。上記条件式（１）～（４）は、それぞれ実施例１～５の内、対応する画面サイズの光学系において満足している（上述の条件式の説明参照）。また以下に、各実施例１～５のその対応する画面サイズの光学系における、前記条件式（１）～（４）の値を示す。

【００６０】

	$\lvert fc/Yb\rvert$	βc	$(Yb/Ys)/\beta c$	$\lvert f2\rvert/fws$
実施例１	6.42	1.29	1.00	1.37
実施例２	6.69	1.29	1.00	1.39
実施例３	5.15	1.43	0.90	1.38
実施例４	9.17	1.18	1.09	1.38
実施例５	３．３４	１．７４	１．００	１．５９

【００６１】

【発明の効果】以上説明したように、本発明によれば、異なる画面サイズの光電変換素子に対応する事が可能であり、小型化，高画質化を達成するために好適な撮影光学系を提供する事ができる。

【００６２】特に、請求項１によるならば、鏡胴構成を単純にして小型化を図る事ができる。

【００６３】また、請求項２によるならば、更に光学系を小型化する事ができる。

【図面の簡単な説明】

【図１】第１の実施形態の撮影光学系（第１画面サイズ）のレンズ構成を示す図。

【図２】第１の実施形態の撮影光学系（第２画面サイズ）のレンズ構成を示す図。

【図３】第２の実施形態の撮影光学系（第１画面サイズ）のレンズ構成を示す図。

【図４】第２の実施形態の撮影光学系（第２画面サイズ）のレンズ構成を示す図。

【図５】第３の実施形態の撮影光学系（第１画面サイズ）のレンズ構成を示す図。

【図６】第３の実施形態の撮影光学系（第２画面サイズ）のレンズ構成を示す図。

【図７】第４の実施形態の撮影光学系（第１画面サイズ）のレンズ構成を示す図。

【図８】第４の実施形態の撮影光学系（第２画面サイズ）のレンズ構成を示す図。

【図９】第５の実施形態の撮影光学系（第１画面サイズ）のレンズ構成を示す図。

【図１０】第５の実施形態の撮影光学系（第２画面サイズ）のレンズ構成を示す図。

【図１１】実施例１（第１画面サイズ）に対応する無限遠の収差図。

【図１２】実施例１（第２画面サイズ）に対応する無限遠の収差図。

【図１３】実施例２（第１画面サイズ）に対応する無限遠の収差図。

【図１４】実施例２（第２画面サイズ）に対応する無限遠の収差図。

【図１５】実施例３（第１画面サイズ）に対応する無限遠の収差図。

【図１６】実施例３（第２画面サイズ）に対応する無限遠の収差図。

【図１７】実施例４（第１画面サイズ）に対応する無限遠の収差図。

【図１８】実施例４（第２画面サイズ）に対応する無限遠の収差図。

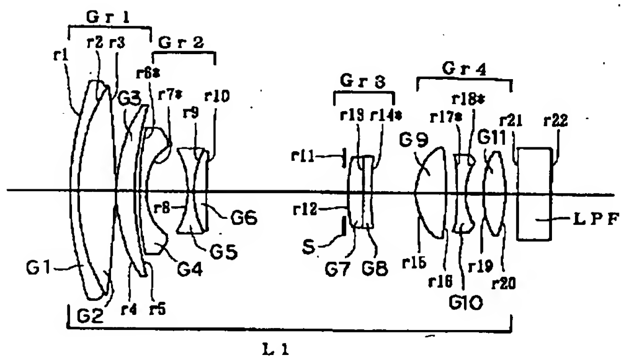
【図１９】実施例５（第１画面サイズ）に対応する無限遠の収差図。

【図２０】実施例５（第２画面サイズ）に対応する無限遠の収差図。

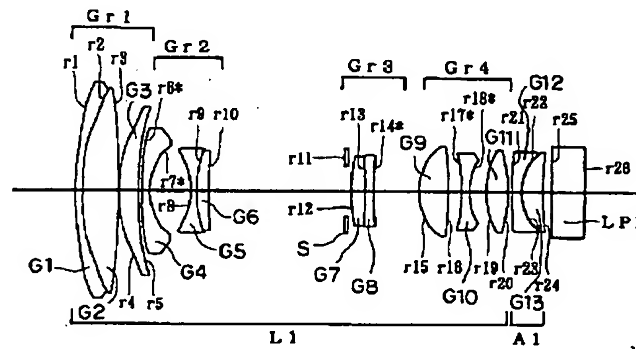
【符号の説明】

Ｌ１～Ｌ５　主光学系
ＬＰＦ　ローパスフィルター
Ａ１～Ａ５　変換光学系
Ｇｒ１　第１レンズ群
Ｇｒ２　第２レンズ群
Ｇｒ３　第３レンズ群
Ｇｒ４　第４レンズ群
Ｇ１～Ｇ１３　レンズ
Ｓ　絞り

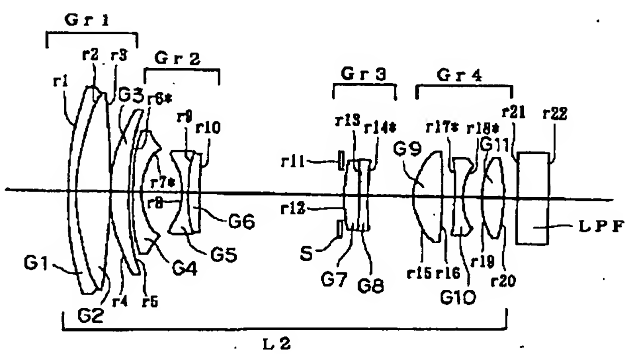
【図１】



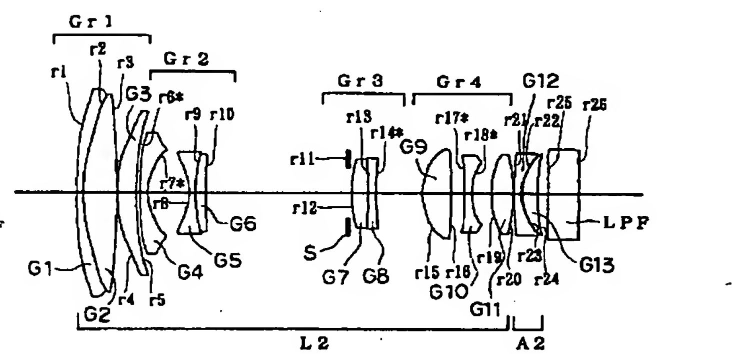
【図２】



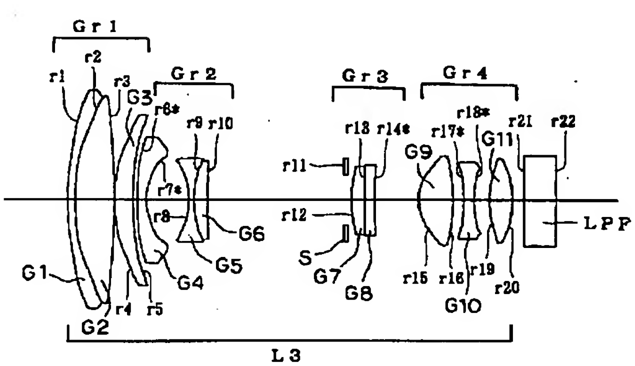
【図３】



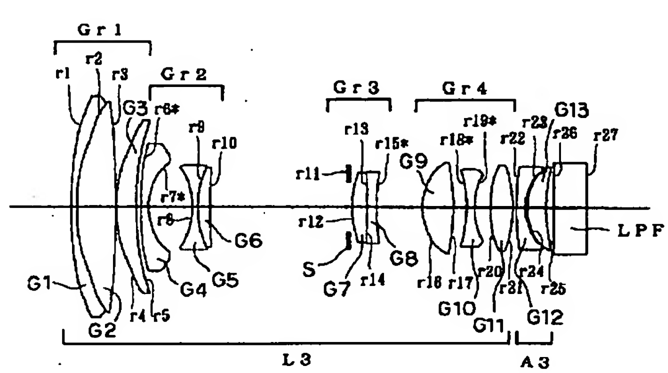
【図４】



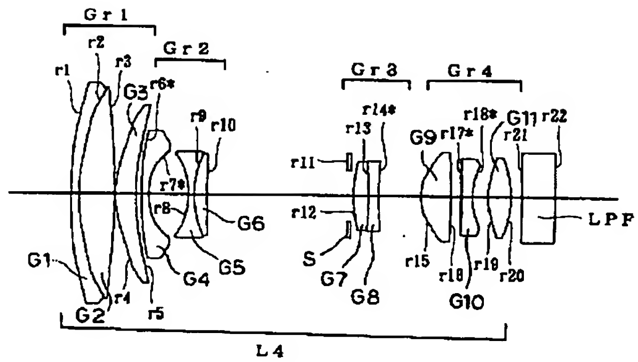
【図５】



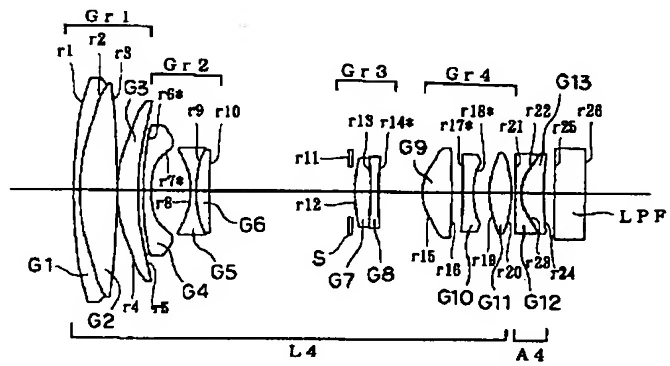
【図６】



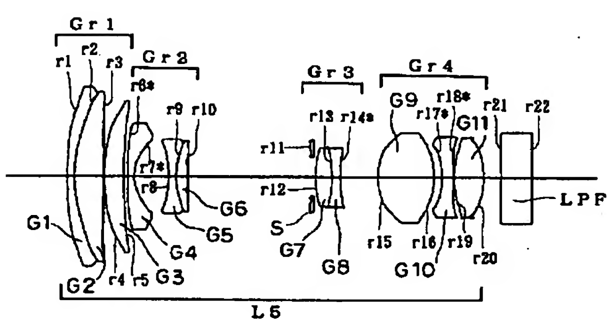
【図７】


Gr1
Gr2
Gr3
Gr4
r1
r2
r3
r4
r5
r6*
r7*
r8
r9
r10
r11
r12
r13
r14*
r15
r16
r17*
r18*
r19
r20
r21
r22
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
S
LPF
L4

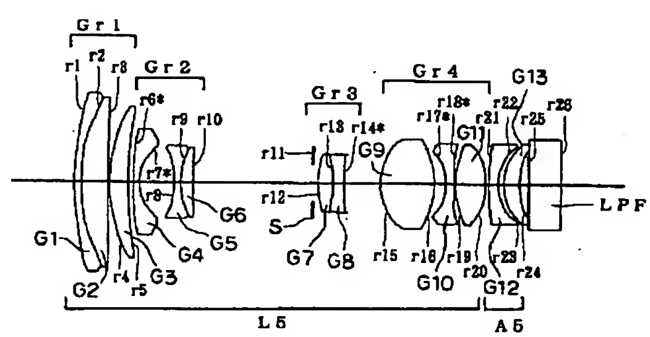
【図８】


Gr1
Gr2
Gr3
Gr4
G13
r1
r2
r3
r4
r5
r6*
r7*
r8
r9
r10
r11
r12
r13
r14*
r15
r16
r17*
r18*
r19
r20
r21
r22
r23
r24
r25
r26
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
G12
S
LPF
L4
A4

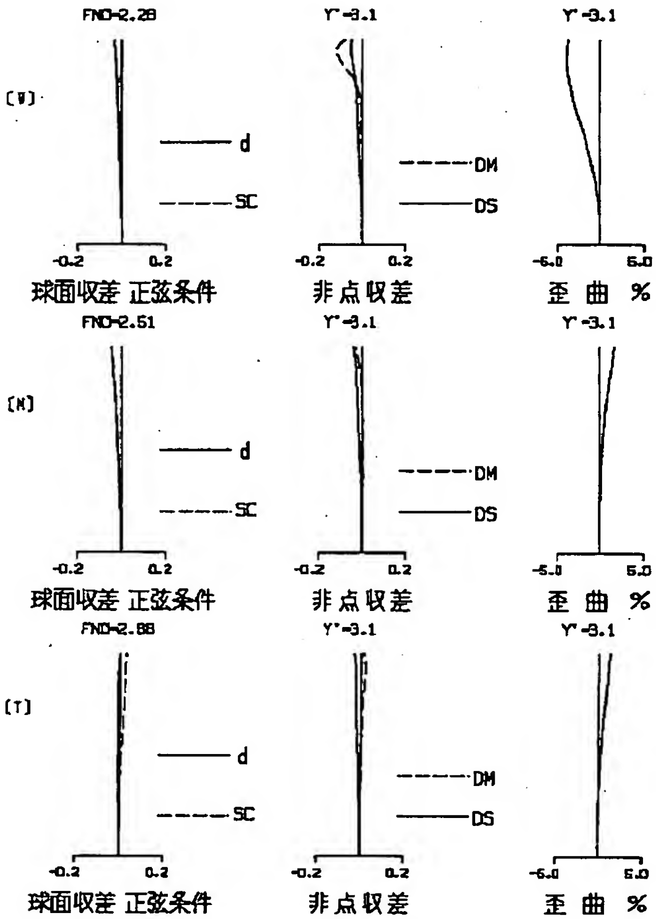
【図９】


Gr1
Gr2
Gr3
Gr4
r1
r2
r3
r4
r5
r6*
r7*
r8
r9
r10
r11
r12
r13
r14*
r15
r16
r17*
r18*
r19
r20
r21
r22
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
S
LPF
L5

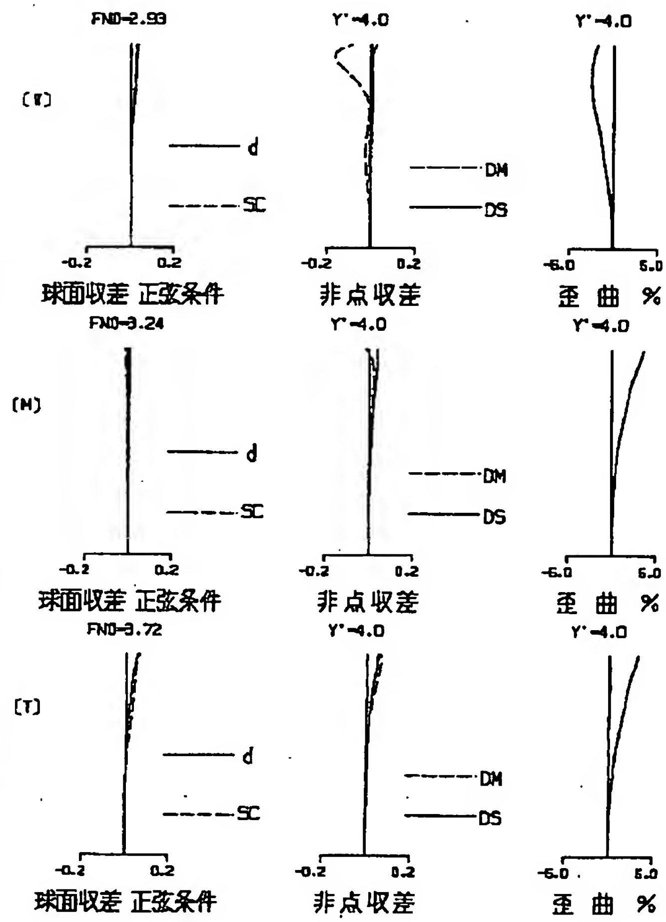
【図１０】


Gr1
Gr2
Gr3
Gr4
G13
r1
r2
r3
r4
r5
r6*
r7*
r8
r9
r10
r11
r12
r13
r14*
r15
r16
r17*
r18*
r19
r20
r21
r22
r23
r24
r25
r26
G1
G2
G3
G4
G5
G6
G7
G8
G9
G10
G11
G12
S
LPF
L5
A5

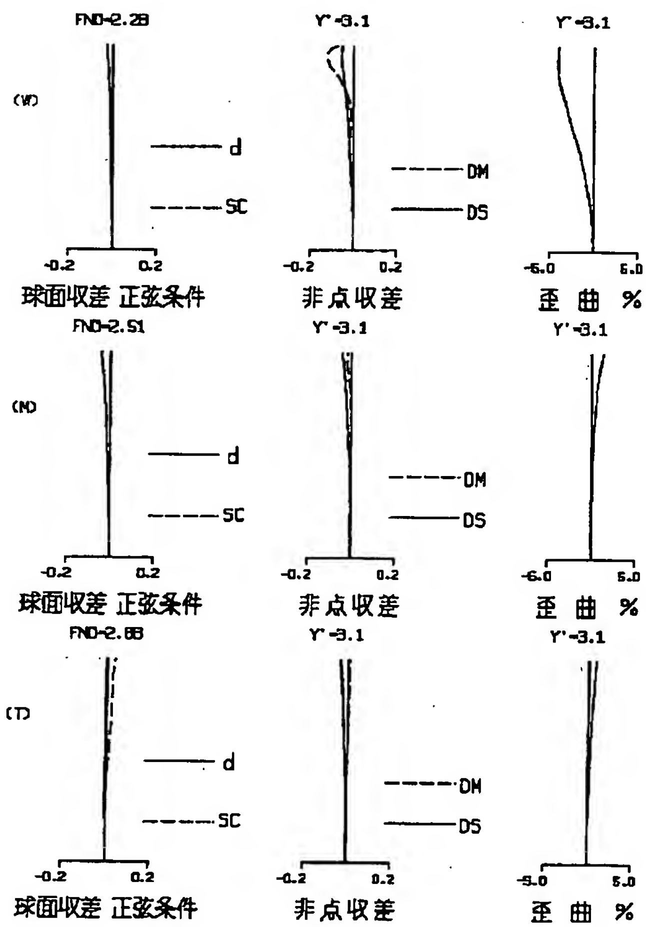
【図１１】


FNO=2.28
Y'=3.1
Y'=3.1
[W]
d
SC
DM
DS
-0.2
0.2
-0.2
0.2
-6.0
6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=2.51
[M]
FNO=2.88
[T]

【図１２】

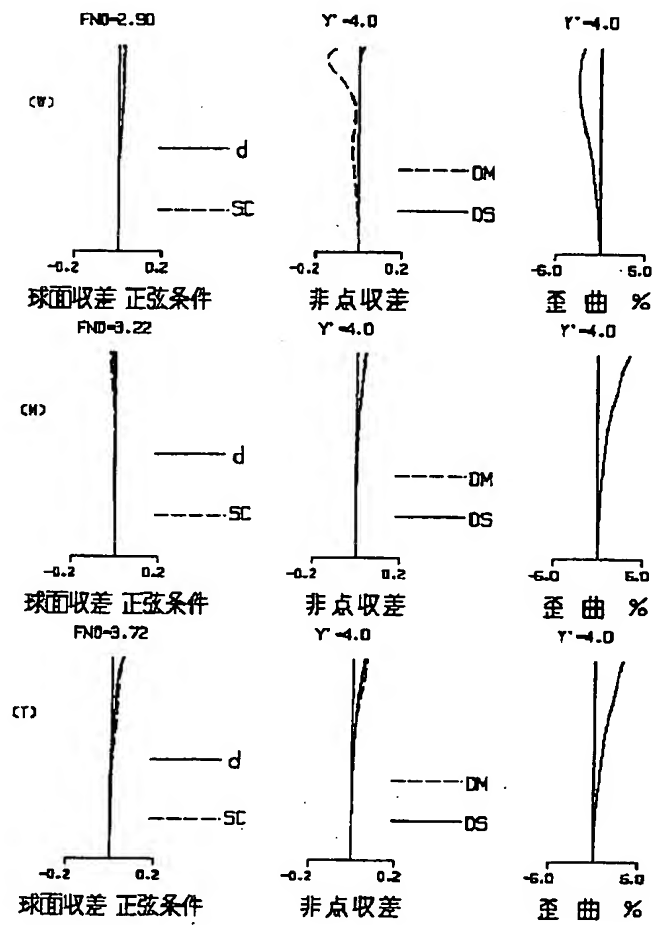

FNO=2.93
Y'=4.0
Y'=4.0
[W]
d
SC
DM
DS
-0.2
0.2
-6.0
6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.24
[M]
FNO=3.72
[T]

【図１３】



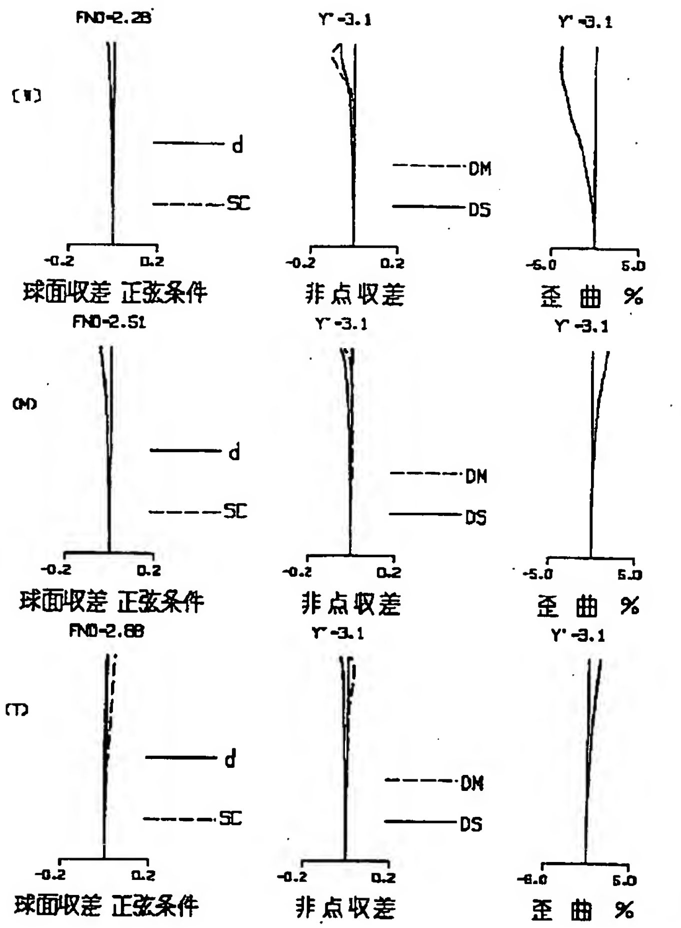
FNO=2.28
Y'=3.1
Y'=3.1
(W)
d
SC
DM
DS
-0.2 0.2
-0.2 0.2
-6.0 6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=2.51
Y'=3.1
Y'=3.1
(M)
FNO=2.88
Y'=3.1
Y'=3.1
(T)

【図１４】

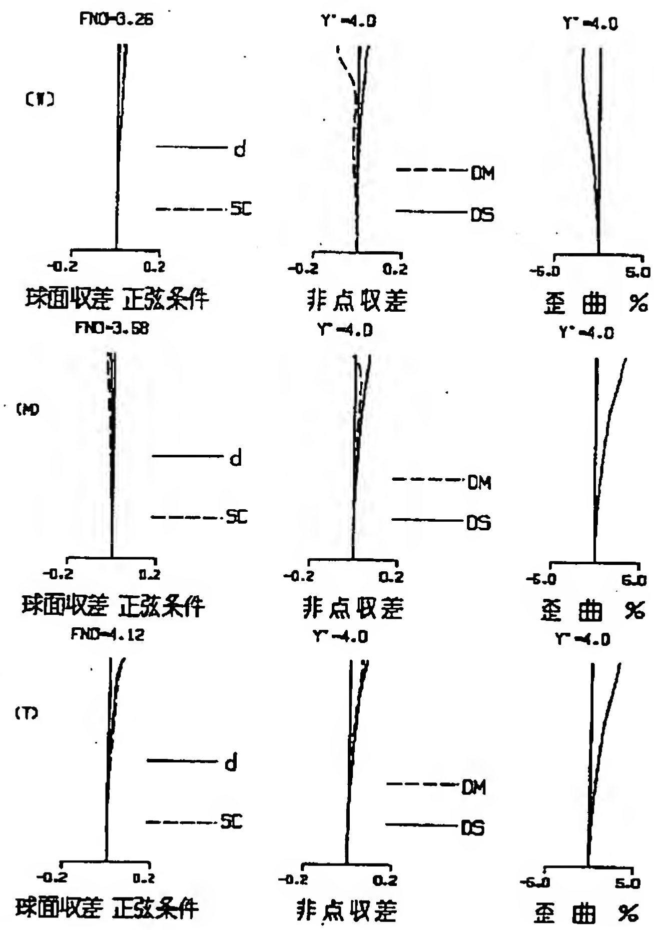


FNO=2.90
Y'=4.0
Y'=4.0
(W)
d
SC
DM
DS
-0.2 0.2
-0.2 0.2
-6.0 6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.22
Y'=4.0
Y'=4.0
(M)
FNO=3.72
Y'=4.0
Y'=4.0
(T)

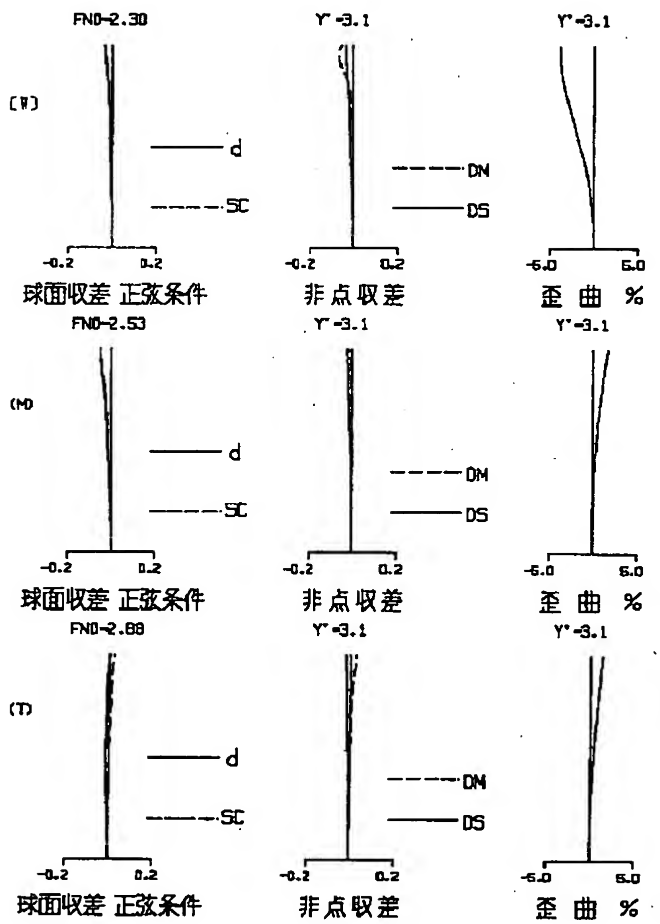
【図１５】


FNO=2.28
Y'=3.1
Y'=3.1
(W)
d
SC
DM
DS
-0.2 0.2
-0.2 0.2
-5.0 5.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=2.51
Y'=3.1
Y'=3.1
(M)
球面収差 正弦条件
非点収差
歪 曲 %
FNO=2.88
Y'=3.1
Y'=3.1
(T)
球面収差 正弦条件
非点収差
歪 曲 %

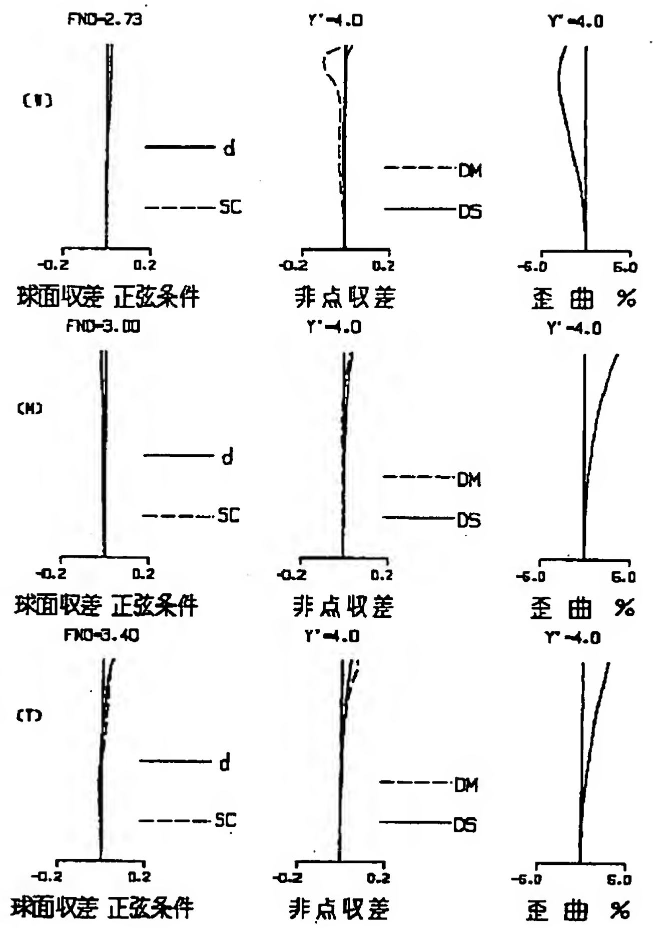
【図１６】


FNO=3.26
Y'=4.0
Y'=4.0
(W)
d
SC
DM
DS
-0.2 0.2
-0.2 0.2
-5.0 5.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.58
Y'=4.0
Y'=4.0
(M)
球面収差 正弦条件
非点収差
歪 曲 %
FNO=4.12
Y'=4.0
Y'=4.0
(T)
球面収差 正弦条件
非点収差
歪 曲 %

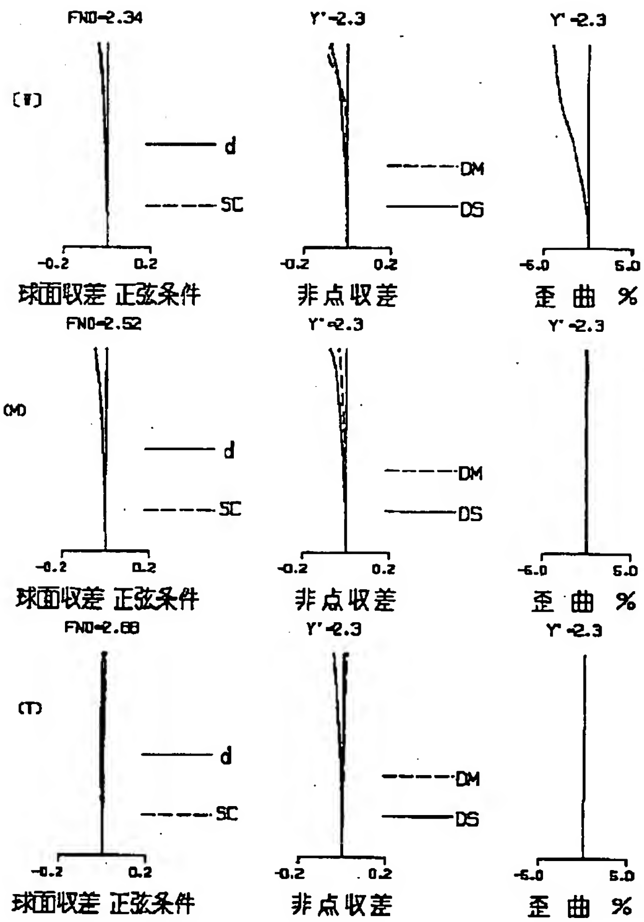
【図１７】


FNO=2.30
Y'=3.1
Y'=3.1
(W)
d
SC
DM
DS
-0.2
0.2
-6.0
6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=2.53
(M)
FNO=2.88
(T)

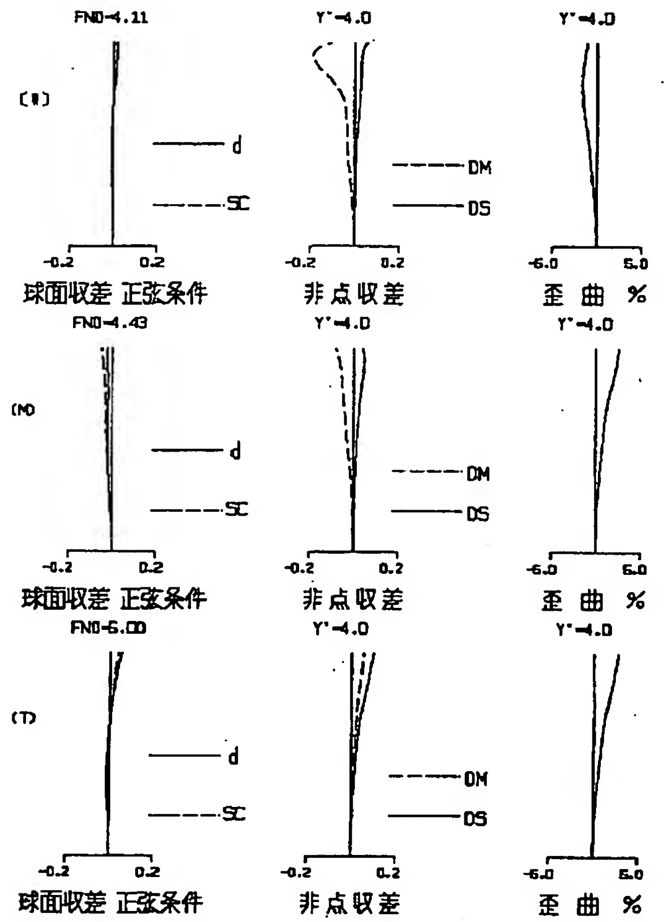
【図１８】


FNO=2.73
Y'=4.0
Y'=4.0
(W)
d
SC
DM
DS
-0.2
0.2
-6.0
6.0
球面収差 正弦条件
非点収差
歪 曲 %
FNO=3.00
(M)
FNO=3.40
(T)

【図１９】



【図２０】



フロントページの続き

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Ｈ０４Ｎ　5/232		Ｈ０４Ｎ　5/232	Ａ

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2H087 KA01 LA30 PA02 PA08 PA10
PA11 PB11 PB13 QA02 QA06
QA07 QA17 QA21 QA25 QA32
QA34 QA42 QA45 RA05 RA12
RA13 RA32 RA42 RA43 RA44
SA23 SA27 SA29 SA32 SA43
SA47 SA49 SA52 SA56 SA63
SA65 SA72 SA74 SA76 SA89
SB04 SB14 SB23 SB34 SB43
5C022 AA13 AB66 AC54 AC55